MAY 4, 1959

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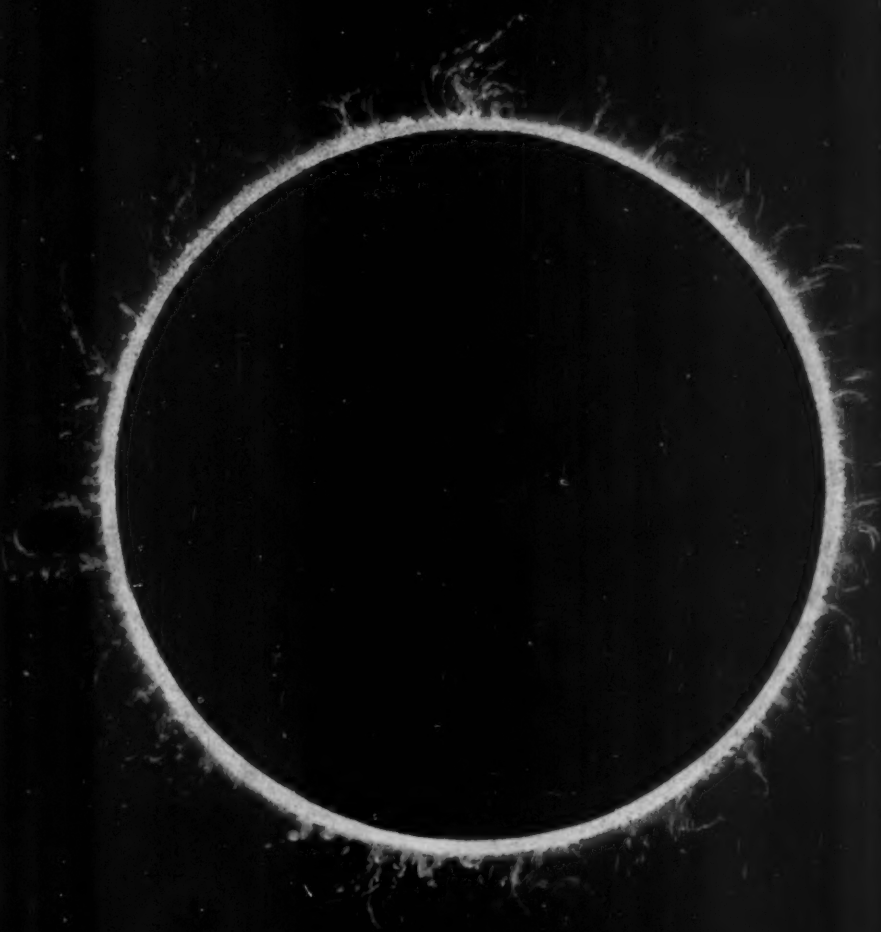
RESEARCH and DEVELOPMENT news issue

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT



edge of the unknown . . .

. . . see page 27

FIRST in strain measurement

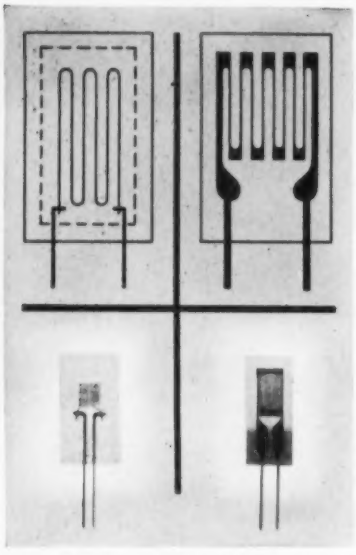
SR-4 BLH BALDWIN LIMA-HAMILTON

STRAIN MEASUREMENT

DATA SHEET No. 1

Useful information about SR-4® strain gages

MEET THE SR-4® BONDED FILAMENT STRAIN GAGE



Bonded wire and bonded foil strain gages are available in a wide range of designs to meet every gaging need. Drawings show typical grid configurations.

Light as a feather, small as a postage stamp, more accurate than a fine micrometer, the bonded filament resistance strain gage has long been accepted by engineers and designers as a virtually indispensable research tool. Its function is to detect the minute strains present at the surface of any solid material, component, or structure under stress, and it is so sensitive that it will react to the pressure of a child's finger on a solid steel column an inch or more in diameter.

Consisting of a looped filament of extremely fine wire or foil, sandwiched between two layers of flexible insulating material, the strain gage is deceptively simple in appearance. Actually, it is the end result of a carefully-controlled, high-precision manufacturing process.

Its operation, as simple in theory as its appearance, depends on the fact that a conductor's electrical resistance changes linearly with longitudinal distortion. The grid of a gage bonded to a surface will stretch or compress slightly with surface strain, thus changing its resistance to a small current passing through it and providing a measure of surface strains as small as one part in a million. Compression of the grid material is possible because of firm bonding to flexible backing layers.

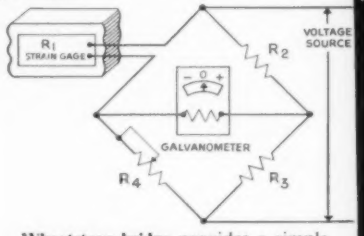
A NEW ERA IN MECHANICAL DESIGN

The SR-4® Bonded Strain Gage was developed in the late 1930s. Designers and engineers soon began to find that this tiny, inexpensive device held the key to some of their most stubborn problems. No longer was it necessary to overdesign critical machine parts and structural members by 400 or 500% to allow for unknown local stresses, to cut-and-try component designs because the exact nature and magnitude of their service loads were not known, or to track down and correct repeated service failures through trial and error methods.

Equally effective in measuring both static and dynamic strains (0 to 50,000 cps and higher), the bonded strain gage quickly found literally thousands of applications in such growing fields as aircraft and automotive design, machine design and construction, and became a familiar tool in virtually every research and development laboratory. It has provided stress analysts with data which made possible lighter, stronger, more efficient turbine blades, connecting rods, gun barrels, locomotives, bridges, dams, artificial limbs, and countless other products of our growing technology. Probably its greatest contribution has been in the aviation field, where it has played an essential role in the development of virtually all modern designs.

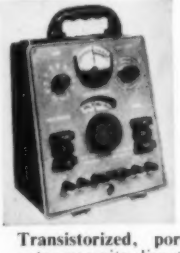
THE BASIC STRAIN GAGE CIRCUIT

The change in gage resistance (ΔR) with strain is usually of the order of only a few thousandths of an ohm. To detect and measure these minute changes accurately a modified form of the familiar Wheatstone bridge is usually used. The strain gage, bonded to the surface to be tested, forms one of the resistance arms of the bridge circuit. The bridge is balanced in some manner (e.g., by adjusting R_1) with the gage unstrained. Resistance of the gage changes with the strain. This unbalances the bridge, producing a galvanometer reading proportional to the strain. In practice, static strains are usually measured by rebalancing the bridge while the strain is applied, the calibrated control providing a measure of unit strain in microinches per inch.



Wheatstone bridge provides a simple, highly accurate means of measuring strain gage resistance. Initial balance is achieved by adjusting variable resistor R_1.

Commercial strain indicators, like the transistorized, portable unit shown, include an internal bridge circuit to which the active gage may be connected. When a number of gages are involved in a test, a multichanneling-and-balancing unit is used to apply the output of each gage in turn to a single indicator and/or recorder.



Transistorized, portable strain indicator permits direct reading of strain in microinches per inch. Operates from self-contained battery or 110 volt, 60 cycle power.

SIGNIFICANCE OF "SR-4®"

"SR-4" is a registered trademark of the Baldwin-Lima-Hamilton Corporation. It is used to identify all of the company's bonded filament strain gages and strain gage instruments.

The S and R are the surname initials of E. E. Simmons and A. C. Ruge, who developed the bonded strain gage independently, but almost simultaneously. The 4 honors the group of four men who initiated commercial manufacture of the strain gage.

Close to a million SR-4® Strain Gages are produced every year. These consist of over 250 different types, for application in virtually every major industry.

There is a right gage for every job. The new B-L-H strain gage catalog contains a wealth of information that could be helpful to you in making the right selection. For a free copy, write Dept.15-E.

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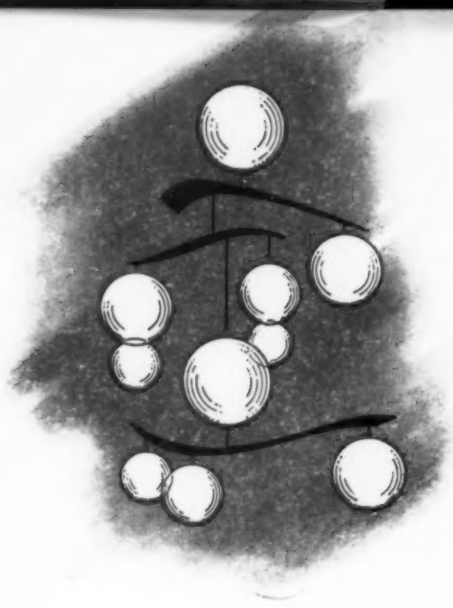

next week . . .

a **Product Engineering**

special report . . .

ENGINEERING ORGANIZATION *in transition*

a study of some 50 organizations, showing their latest setups, with notes on . . .

- **REASONS FOR CHANGES,**
- **BUDGETING,**
- **JOB TITLES, AND**
- **RATIOS OF ENGINEERS TO TOTAL COMPANY EMPLOYMENT.**

Watch for this 24-page staff-written feature article in the

DESIGN issue for May 11

in addition

the DESIGN issue for May 11

FEATURES

- **For rough handling—these shock tests**
  Two simple test-drop methods with curves, equations and sample problems.

- **Buckling in hydraulic tubing**
  Solid column analysis provides the answers whether loading is mehanical or fluid pressure.

- **Dynamic programming—a new tool for maximization**
  How to use this new mathematical tool, along with examples in finding an optimum.

- **Powder metallurgy can compete with stamping**
  Some cogent arguments for considering powder for parts normally made from sheet metal.

- **Strength and deflection of shafts**
  A four-step method to simple solutions.

- **9 ways to align mating parts**

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN RESEARCH AND DEVELOPMENT

R and D RESEARCH and DEVELOPMENT news issue

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Product Engineering ..... SIDELIGHTS

R and D RESEARCH and DEVELOPMENT news issue

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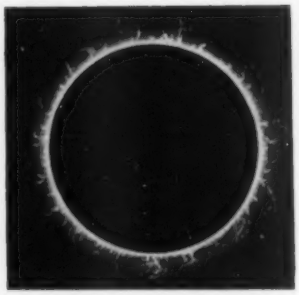

● **They've been calling our century a technological explosion** and it's still going strong (p 27). If you picture an explosion as we do—the parts of a complex assembly flying off in all directions—then the phrase is not entirely complimentary, if apt. For one thing, the sum total of human knowledge is now doubling every 15 years, but information is accumulating far more rapidly than we are equipped to handle it. The Library of Congress is desperately looking for more space. Conferences and international congresses meet every month or two to discuss methods of information storage and retrieval. It's a sort of embarrassment of riches and we're reminded of the donkey halfway between two haystacks who starved to death because he couldn't make up his mind.

● **It's rumored that the automobile companies** are a hotbed of spies, counterspies and supersecrecy these days. A shaped tailfin or a chromium curve would be stolen more quickly than a gasoline pill. It's strange, therefore, to glance over some of the socalled "new car buyers' guides" published by these same companies. Have you seen them? After spending a year stealing their competitors blind, they carefully print up part-by-part comparisons of best-known makes, with no flattery to competitors intended at all. Imitation is still the sincerest . . . etc.

● **Lest you throw your arm out of joint** patting your back, here's a report from Detroit that we'll repeat without comment. A Chevrolet master mechanic, says the Detroit *Times*, has invented and built a robot that can smoke, mix secret chemicals, dance, play the harmonica, answer the telephone and do the dishes. The robot is 5 ft 5 in. tall, weighs 100 lb and costs only $4000 for parts. It operates without connecting cables and carries no batteries. Power is transmitted by a secret device from as far away as 35 ft. To top it off, the robot (named Blockhead by his inventor) strolled down to the neighborhood park one fine morning and outclassed several players at the shuffleboard courts.

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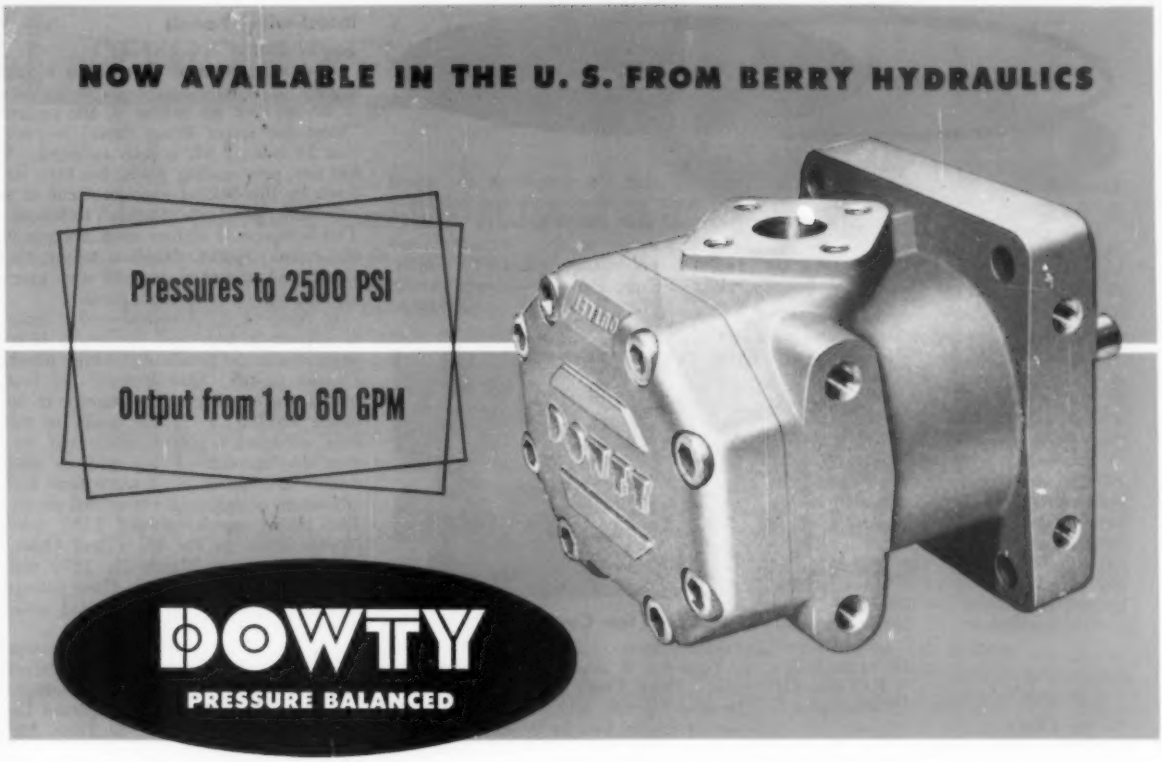

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Address_____

Reader To Editor...

Eastern Drafting Council

To the Editor:

In reference to the activities of our Design and Drafting Council of Delaware Valley contained in your article, "Dialects in Engineering" (Mar 30, p 41), we will be pleased to provide information regarding our activity to anyone who inquires.

You may be interested in knowing that at the present time, we have 82 teachers pursuing a 12-week course in the evenings. This is offered in two locations; one at the University of Pennsylvania, and one at Temple University. The presentations are offered by chief draftsmen from local industries. This is the second year we have conducted the series. Response has been so enthusiastic we were unable to provide for all those who applied. The course is free and is intended for just the purpose you note in your article.

—Joseph D Dolan, secretary
Design & Drafting Council of Delaware Valley
P O Box 431
Philadelphia 5

To the Editor:

Your editorial, "Dialects in Engineering" (Mar 30, p 41), was most interesting. Here at Arma, we have published a brochure on engineering standardization which answers many questions posed in your editorial.

—F J Kirch, sr engineer
American Bosch Arma Corp
Garden City, N Y

Wrong Inventor

To the Editor:

In the April 13 issue (p 7) of PRODUCT ENGINEERING, there is a story which credits me with having invented and marketed the "one-armed bandit," and further, with having carried on a very substantial and wholly illegal enterprise in the development of various gambling devices since.

I am a practicing lawyer born a full generation after Fey and Mills developed the first gambling slot machine, and emphatically have nothing to do with the very substantial illegal industry that has flourished all these years. I have a reputation based on identification with good criminal law enforcement which has subjected me to let us say some rather barbed kidding.

—Rufus King
Washington, D. C.

• Apologies to Mr. King for our error. —Ed.

Is Moon Money Wasted?

To the Editor:

In your editorial "Because It's there" (Apr 6, p 21) the point is well taken, but aren't there many projects, scientific, medical, social, etc., that create wonder and curiosity that could make better use of the time, money, and effort expended on the moon project. Many feel it is a certainty that the people of the world will never get along with one another—that there shall always be wars. Wouldn't the questioning of this "certainty" and the upsetting of this applecart be wonderful? It's there too!

—Edwin Appel
Baltimore

Periscope for Cars

To the Editor:

Your Apr 6 issue, particularly the column "Why Don't they Research and Develop" p 60, reminded me of some ancient history here in Wilmington. The suggestion of Mr. Dritz to develop a periscope rearview mirror for automobiles was presented to the public back in Nov 1952. A device was developed by Mr. Ekman Myers of Pompton Lakes, NJ, using our "Lucite" acrylic resin. I have no idea what has become either of Mr. Myers or of his viewing device, but it struck me as being an interesting story anyway. Perhaps you will agree.

—Charles S Booze Jr
E I Du Pont De Nemours & Co
Wilmington, Del

Faster Reading

To the Editor:

In *Product Engineering* for January 12, 1959, the second lesson on Five Steps to Faster Reading was presented. This article dealt with phrase reading and focusing the eye on the center of the space above the phrase being read. Perhaps an interesting experiment could be made by printing an article in the magazine by phrases. Thus the reader's attention would be focused directly on the pharse and faster more efficient reading may result.

—W H Francisco
senior staff engineer
Minneapolis-Honeywell Regulator Co
Minneapolis, Minn

Insect-wing Panels

To the Editor:

It is most unusual to read an article descriptive of seemingly novel techniques or devices that are familar to the reader. "Meet the Insect Wing Panel" in your Mar 16 issue, p 62, is such an article. I feel that your reading public has been let down by this belated announcement of a structural panel fabrication technique. This technique is neither novel nor was it of German descent. Needless to say, the article will stimulate interest and more applications for this type panel.

In April of '57 I commenced a series of evaluation tests and fabrication technique studies on panels of this type which I chose to call "Skin Blister." At that time I, too, considered the concept to be novel. By July of '57 the results of the tests warranted a patent search and further development. I expected to find similar approaches to construction and fabrication of lightweight structural panels. The patent search revealed (19) prior patents issued by the US Patent Office, which date from March 25, 1879 and through September 6, 1949. These patents substantially cover all claims and areas discovered in the article, as well.

—C Werntz
Construction & Fabrication Research Manager
Hussman Refrigerator Co
St. Louis, Mo

• Mr. Werntz' list of pertinent patents on request.—Ed.

There Goes $5 Million

To the Editor:

I wish to compliment you on your editorial in the Mar 9 issue (p 23) I first saw a V-2 Rocket at the Air Force Show at Grand Central Palace in 1949. It was in the same room with a P-80 "Shooting Star." The V-2 looked like it was made by an amateur tinsmith; the P-80 as if it were carved from ivory.

The contrast was so significant that it brought home with tremendous impact the very fact which you bring out so well in your editorial.

We may also note that many projects built as so-called "breadboards" in a rather haphazard fashion will operate very successfully whereas after thousands of hours of expensive engineering time the production prototype develops an infinite number of bugs which may make this production design a critical and temperamental device.

Every time one of our satellite rockets is launched I think to myself, "There goes five million dollars." Most of these are destroyed in a few moments. Surely it would be better to get the same operational yield by launching five rockets costing a half million dollars apiece. One slogan which I use frequently is, "The last 5% of perfection represents 95% of the cost." Since many items are perfectly acceptable at 95% of perfection, your editorial really hit home.

—W J Oestreicher
Pierpont Industries Inc
Brooklyn, NY

DEVELOPMENTS TO WATCH...

American

More-ductile columbium at lower cost . . .

. . . may stem from research now under way at Thompson Products in Cleveland.

In a report prepared for the Electrochemical Society, R. H. Hiltz Jr, of Thompson describes studies of "gettering" or scavenging elements–added during melting—as a means for overcoming the detrimental effects of contained oxygen and nitrogen on columbium's ductility. Five elements have been tested: titanium, aluminum, zirconium, yttrium, and beryllium—each added in unit atomic percentages. Of these, the last two were most effective in removing interstitials from solution and forming hard-particle dispersions, thus reducing the hardness and increasing the ductility of the metal.

Because this approach—addition of scavenging elements during melting of the metal—is basically much simpler than present purification techniques, it might well pave the way for lower costs.

Organometallic boosters for plastics, paints, and jet fuels . . .

. . . move closer to commercialization.

Several of the organo-tin compounds developed by Metal & Thermit Corp, for instance, are now being licensed to such companies as B F Goodrich (for development of new plastics polymers), Mobay (for use as catalysts in urethane foams), and Dow (for new fungicides for paints and other materials). At the same time, M&T announces a jet-fuel additive that promises to "permit full-throttle operations at temperatures heretofore unattainable.

(Note: For more on organometallic compounds, see *PE*—Nov 10, '58, p36 and earlier references.)

Refractory fabrics that conduct heat and electricity . . .

. . . become available as National Carbon develops a technique for graphitizing synthetic textiles.

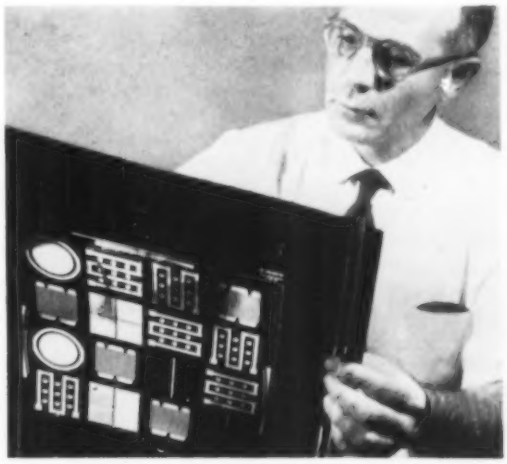
These graphite fibers differ from the "carbon wool" previously available (*PE*—Sep 23, '57, p 5) in most of the ways graphite differs from ordinary carbon. They resist temperatures of 4500 F or more, show excellent electrical and thermal conductivity, and have superior chemical resistance. Like the carbon fibers, though, they are relatively weak fibers and the black is readily rubbed off. However, as National Carbon points out, for many industrial applications, neither factor is a serious limitation. Graphite fiber cloth, for instance, can be incorporated in a plastic laminate, making the laminate electrically conductive and increasing its ability to withstand elevated temperatures; and, at the same time, providing protection for the graphite.

The material is not yet in commercial production, but developmental quantities of fibers, yarns, and textiles may be obtained from C. E. Ford, Industrial New Product, National Carbon Co, 30 E 42nd St, New York 17. Sample prices vary; but, as one example, Ford cites 28 by 28 square weave cloth, samples of which may be obtained for $1.50/sq ft.

Test patterns for printed circuits . . .

. . . may seed a whole new crop of electrical standards. Bell Labs engineers developed the ones shown here to make it possible to evaluate and compare circuits made of different materials.

Circular patterns like the one in the upper left hand corner are specifically designed to test volume and surface resistivity. Dominoes (top center) are for bond strength tests; modules with closely spaced lines (like the one at the upper right), for insulation resistance; blocked squares (2nd and 4th row), for solder-dip resistance; and the single vertical stripe (3rd row center), for water absorption.—ARG



Master test pattern for printed circuits has 16 2-in. modules (with space at the bottom for another row of four); can be printed on any desired base. BTL engineers point out that space between modules is just as important as spacing of lines within them.

The next Sputnik may be a TV relay station . . .

. . . if space devoted to the subject in Russian engineering publications is any criterion. They note that a single orbiting earth satellite could make it possible to cover the USSR, obsoleting all relay stations now built or planned; and three such satellites in the same orbit could cover the world—with Soviet propaganda, of course. The satellites would have to be launched along the equator, in the direction of the earth's rotation, and would have to move at a controlled speed so they would remain in the desired position. Amplification and transmission of the signals would be with some suitable Space Age device, involving transistors, solar batteries, nuclear batteries, and the like.

Wind-powered electrical systems of 10 kw and under . . .

. . . to supply radio and TV relay stations and oil pipeline pumps, provide peak-load assistance for diesel installations, and charge storage-battery systems, are being developed in several European countries, says a recent United Nations report. Among the most interesting: a French 4-kw unit specifically designed for use in connection with cathodic protection of buried metal structures.

Development of wind, solar, and geothermic power has proceeded so rapidly in the past few years, the UN believes, that a second international conference on new energy sources (the first was held about two years ago) would be well worthwhile. An agenda for such a conference has been drawn up and is being submitted to the UN membership for approval.

Among the suggested topics are use of solar energy for mechanical power and high-temperature processing, and geothermic power and heating devices.

Japanese wireless microphone . . .

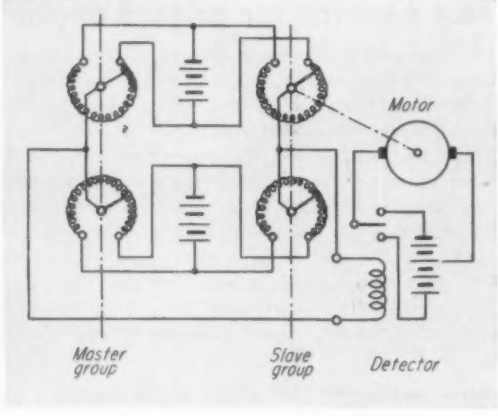
. . . weighs less than 2½ oz, operates on a standard dry cell. Printed circuits help cut size and weight, and a condenser microphone head is said to provide good tonal quality. Over-all dimensions are about 2½ by 2 by 1 in.

Aiko Electric Co of Tokyo, which developed the unit, says its 40.68-mc, 10-milliwatt output can be picked up within a distance of 100 yd by any crystal receiver. Company engineers have, however, designed a superheterodyne receiver and amplifier with automatic frequency control and built-in "squelch". Cost of microphone and speaker set is about $100.

A command control for machine tools, aircraft . . .

. . . and marine steering gear, developed in France, is claimed superior to the usual potentiometer-type transmission system, particularly in its ability to transmit continuous rotary motion.

In the French design (see diagram), master and slave units are composed of pairs of potentiometers with their contact arms fixed on a common spindle. They are so arranged that one is always functioning while the contact arms of the others are wiping the "dead" sector. In this way, the system is able to operate continuously. A detector (a thyratron or magnetic amplifier flip-flop device) supplies the motor with current proportional to the angular displacement between the two potentiometer groups. This, says M. P. Sirven, 39 Rue Dupleix, Sartrouville (Seine-et-Oise), ensures greater flexibility than could be achieved with the relay shown here. If only a low torque is required, however, a miniaturized servomotor can be driven directly from the potentiometers, without need for a detector. —ARG



French servo control can be applied to hydraulic or pneumatic systems, or arranged to actuate an electrical coupling or clutch, its developer claims.

Design of motor vehicles . . .

and their equipment are coming under federal scrutiny. Already the government lays down requirements for safety equipment such as lights, brakes, etc., for trucks and buses that travel in interstate commerce.

Now, the federals appear ready to go a step further to influence the design of new automobiles. The tip-off came recently in a Bureau of Public Roads study on highway safety as prepared at the request of Congress.

The study, rated as one of the most extensive ever compiled, lashes out at the poor safety features of today's futuristically designed automobiles with their wrap-around windshields, and high tail fins.

Crediting the safety improvements that have been made by the automobile industry, the report notes sharply, however, that "changing automobile design sometimes eliminates one hazard only to find a new one in its place. Easy driving is not yet a valid synonym for safe driving."

Cited as an example are the low silhouette models. Although designers have lowered the vehicles' center of gravity and thus improved their stability and riding quality on curves, it has brought troublesome brake problems. The small 14-inch wheels, the report states, reduces the flow of cooling air around brake drums and reduces their effectiveness.

There is other criticism of designs too. "The projectile-like components of the bumpers and bumper guards of some cars are largely nonfunctional and present needless hazards to pedestrians, as do some other embellishments, including projecting hood or fender ornaments."

Specifically, the report blasts high tail fins as reducing rear vision; wrap-around windshields as being safety hazards in bad weather. The wipers fail to clean the end and central areas of such windshields, the report states, leaving blind spots that may be as large as the old-style flat windshields.

Rear end lighting is often confusing, particularly for turn signals, the report states. And, some of the new cars have lowered the height of the taillights, reducing the distance they can be seen by drivers coming over rises in the highways.

Specifically, the report calls for an interdepartmental highway safety board to be established on the federal level to work with states in setting up "leadership, guidance, and coordination" of safety programs.

Reading between the lines, the report seems to indicate that officials would like to set up national design standards on safety factors in autos and trucks.

Foreign patent rights . . .

on inventions made under government research contracts should be denied industry. That is what a staff report to the Joint Committee on Atomic Energy recommends.

The report, prepared by Prof. William K. Chipman of the Univ of Wisconsin Law School, concludes that "General allegations that the present American foreign-patent position is not adequate must be regarded at this time as not proved." It acknowledges, however, that the issue has its share of pros and cons.

Atomic patents are forcing the issue immediately. Policy set on them, however, may well set the pattern for all such patents. Congress is currently wrestling with the issue. A firm policy covering both foreign and domestic patents is expected—see page 15.

A fleet of small nuclear-powered subs . . .

may get the official nod. The Navy's submarine operating staff favors smaller subs. And, the matter is getting a hard look by Navy right now. Preliminary designs are even being drawn.

One problem, however, is getting the size and weight of reactors down to fit into the subs. Thinking is to get a submarine that is roughly 400-tons, carrying about a 12-man crew. This is about ⅓ the size and crew of today's nuclear submarines.

The smaller submarines would become the workhorses of the underseas fleet. They could serve as attack subs, picket duty, scouting, etc.

These efforts come under Project Subic in which the Navy is applying the systems approach to a complete submarine design. Navy hopes that small subs will help comprise fleet of mobile underwater missile launchers that are difficult for an enemy to defend against.

Lockheed Aircraft Corp reportedly is considering the design of such submarines capable of carrying one of the 1,500-mi solid-fueled polaris missiles. The company reportedly is considering adoption of plated, high strength aluminum alloys as possible structural materials for submarines.

WHAT'S HAPPENING IN... Science

More data at higher temperatures

Now that temperatures in the range of 10,000 degrees Kelvin are becoming everyday working tools, the big need is for data and instrumentation that will help engineers take advantage of them.

A good start has been made in this direction. At the last ACS national meeting, for instance, staff members of Temple U's Research Institute reported on their studies of the density of several oxides and fluorides at 1500 to 2500 K. Now they plan to extend their work to still higher temperatures, using fluorine, ozone, cyanogen, metal, and metal hydrides as well as argon and oxygen flames.

Meanwhile, other organizations are working on instrumentation and procedures for elevated-temperature tests. The ACS meeting featured a whole series of reports on these. GE engineers at Hanford told how they have combined a carbon-arc image furnace with a high-temperature microscope to permit study of ceramic compounds at temperatures above 2000 C; and Bureau of Standards scientists described high-temperature microbalance techniques for measuring rates of evaporation.

Much is being done, too, to develop new materials by the high-temperature route. For instance, plasma jets similar to those now being used for welding and cutting are making it possible to produce a whole spectrum of refractory materials. With a nitrogen jet, nitrides can be produced by direct reduction of metals; and argon jets at 10,000 K may produce carbides by the same direct route.

Uranium converts heat to electricity

Uranium may get a brand-new job—as the solid element in the "plasma thermocouple" that takes advantage of differential heating to create a flow of electric current (*PE—Dec 1 '58, p 10*). This heat-to-electricity converter, developed by Univ. of California physicists at Los Alamos Scientific Laboratory, has a thermionic cell that is essentially a gas-filled diode in which an ionized gas or plasma serves as one branch of a thermocouple and a solid semiconductor as the other. In the latest model, cesium vapor is the gas and uranium carbide, or a mixture of uranium and zirconium carbides, serves as the solid element.

Why uranium carbide? Says Los Alamos: It shows unusually high thermionic emission in the 1400 to 1800-K range, and is one of the limited group of materials that can withstand attack by cesium gas. Furthermore, addition of zirconium carbide to the uranium (to form a polycarbide) produces a material that has good strength and resistance to thermal shock and still retains the desirable thermionic characteristics.

(Note: For more on heat-to-electricity conversion, see p 28.)

atom briefs . . .

Effects of fluid contamination on servovalve wear are being studied at Douglas Aircraft with the aid of radioactive atoms. Using powdered iron "tagged" with radioactive iron-59, Douglas researchers can compare the performance of various types of filters simply by measuring the amount of radiation buildup with a scintillation counter, instead of employing complex chemical and physical techniques.

Engineering applications for radioactive tracers are growing fast. A brief listing of those described at the National Industrial Conference Board's Atomic Energy Conference includes not only the valve study (above), but also investigations of adsorption and surface structure as they affect adhesive bonding, evaluation of cleaning systems, and wear of rollers and gears, all of which were aided by radioactive atoms. —ARG

Golden reactor

AEC's second try at a homogeneous reactor using uranyl phosphate fuel is getting underway—and the reactor itself is literally worth its weight in gold. The first try—LAPRE I—failed owing to excessive corrosion. In the second, pictured here, all structural materials in contact with the fuel solution are plated or clad with gold.

The initials LAPRE, incidentally, stand for *Los Alamos Power Reactor Experiment*. It's designed to produce superheated steam for electrical power generation. Others being designed or built at the same station include the LAMPRE (*Los Alamos Molten Plutonium Reactor Experiment*), and TURRET, a high-temperature gas-cooled reactor using uranium-impregnated graphite in a solid fuel-moderator combination designed to produce processed heat rather than electrical power.

Gold-clad heat exchanger of new Los Alamos reactor is lowered into its gold-lined tank. Despite its small size, this homogeneous reactor is expected to generate 1000 kw of heat.

WHAT'S HAPPENING IN... Materials

New material to challenge nylon

An acrylonitrile-styrene-butadiene resin that can challenge molded nylon on its home ground—in electrical and engineering applications—is promised by US Rubber's Naugatuck Chemical Div. Now being readied for commercial introduction, the material Kralastic K-2590, is said to show excellent rigidity, strength and heat resistance, and to be easy to form. Its moisture absorption is barely one-fifth that of nylon.

USR isn't saying it will outperform nylon in every respect; or replace it in all applications. But the company does believe it will rate consideration in many applications where nylon is now used.

Detailed engineering data on the material will be presented in a forthcoming issue.

More leeway with flexible printed cables

Having made its commercial debut only a few years ago as a few parallel lines printed on ordinary plastic film, flexible printed wiring can point with pride to its progress.

Today, straight-line cables are available not only in standard materials, but also on TFE and CTFE fluorocarbon films. LaPointe Industries Inc, for instance, is ready to supply these on order in lengths to 60 in., encapsulated if desired, and with or without shielding.

As W. B. Wilkens of Sanders Associates pointed out at the last IRE meeting, multilayer construction and other new techniques make it possible "to break out feeder conductors from any trunk-line conductor at any point along the trunk line."

The wires can be made smaller, and brought closer together too. Flexible circuits with 0.010-in. lines spaced 0.005 in. apart are no longer considered unusual.

Accordion-pleating techniques are being developed for pre-crimping cables so they will provide the necessary elasticity for sliding-drawer installations; and new designs are being developed to eliminate the need for slip rings in gimbal wiring for oscillatory devices.

Progress is also being made in developing connectors for the circuits. A greater variety could probably still be used, but there are now enough types to permit at least moderate design freedom.

Design can "make-do"

Good engineering can solve materials problems; or, at least, bring them down to manageable size, says George Gerard of NYU; and, at ONR's Science Symposium (*PE*—Apr. 6, p 9), he cited this example:

To cope with aerodynamic heating and provide thermal protection; it's common practice to design homogeneous structures that combine the three functions of load transmission, environmental protection, and contouring. But, if those three functions are split among components of a composite system, it's much easier to take advantage of the best materials for each and simplify materials needs.

When gaseous or liquid coolants can take over the environmental protection function, the structure itself need only be designed to handle load-transmission and contouring.

When sinks or radiation shields can be provided, they should be able to provide environmental protection, and take over a good part of the structural job as well.

A lot more must be learned, though, Gerard says, about the efficiency of such cooling techniques, and about their limitations.

Ablation or heat-sink systems, he notes, can only absorb a certain amount of heat per unit area. Consequently, they are time-limited in their effectiveness.

Radiative systems, on the other hand, are basically limited by temperature (or heat flux).

The present design approach to heterogeneous systems, he says, generally involves layered structures. But, he predicts, "Ultimately we may envision the composite system as a heterogeneous solid possessing the desired variable mechanical and physical properties through the thickness which will simultaneously satisfy all of the design functions."

briefs . . .

Plastic permanent-magnet strips developed by B F Goodrich are finding their first large-scale application in refrigerator door seals. Here, these specially compounded Koroseal vinyl plastic strips are used inside a Koroseal gasket "to form a perfect airtight seal around the entire perimeter of the refrigerator door . . . and eliminate the need for a latch."

Goodrich says the plastic can be extruded in continuous lengths and spot-magnetized or shape-magnetized "in any direction." In the type now being made, specific gravity is 3.7; coercive force (Hc-oersteds) 1150; BH (max), 0.402 x 10^6; BR (gauss), 1400. Expected applications range from motors to hearing aids.

Machinable ceramics that can be fired in standard furnaces without shrinkage allowances are offered by Duramic Products Inc. A further development of a low-thermal-expansion material introduced by the company last year, the new material is said to stand temperatures to 2200 F, is available in rods and disks ⅜ to 2½ in. dia.

Facts on fibers: A glossary of fiber technology, tables of properties, and a bibliography are contained in the latest edition of *Fiber Facts*, a plump little calendar memo book (2½ by 4 in., 76 p) published by American Viscose. Copies may be obtained from Avisco's Product Information Service, 1717 Pennsylvania Blvd., Philadelphia 3. —ARG

In the automotive industry alone, there are 30 Cold Bonderite installations.

How Cold Bonderite System cuts costs

Some actual user-experiences of savings in heat requirements, maintenance, water and electricity, and equipment after installing Cold Bonderite System.

Less than two years ago, the first public announcement of Parker's Cold Bonderite System was made.

Now, well over a hundred plants are using this revolutionary, money-saving system of phosphate-treating at low temperatures.

Some are among the country's largest plants, others are quite modest in size and production. Products treated range the list from automobile bodies to small appliance components.

From these users we have compiled a long list of documented savings records. In many cases, cost reductions have been greater than we had hoped to achieve.

Heat Saved

The greatest percentage savings in heat requirements (90%) has been reported by an automotive plant. Before installing Cold Bonderite System, the finishing line used 50,000 pounds of steam an hour. Cold Bonderite in the line uses only 5,000 pounds per hour.

In another auto plant, heat savings are figured at 74% on a body line. A small parts finishing line in the same plant shows the same percentage reduction in heat requirements.

The temperature tells the story! Cold Bonderite System solutions operate 60° to 75° cooler.

A manufacturer of metal cabinets reduced gas consumption for heating his phosphating line from 33,000 to 14,000 cu. ft. per day—a 56% reduction—by installing the Cold Bonderite System.

A famous maker of household equipment changed from conventional phos-

phating to Cold Bonderite System and saw his steam use plummet 66%.

Another manufacturer, an Eastern small appliance maker, reports that on gas expense alone he has cut his phosphating costs 45%.

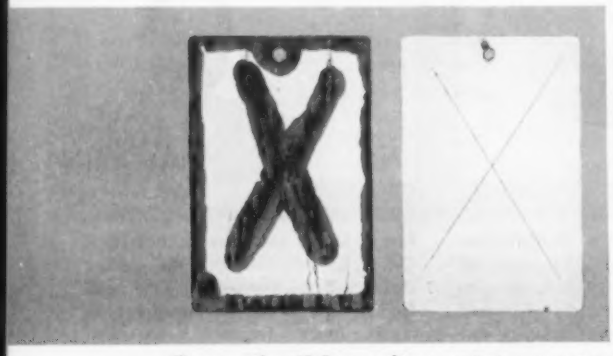
Other Savings Pile Up

The magnitude of other savings, beyond heat consumption, has been surprising to users and very good news to their cost accounting departments.

Electricity, for instance. At the greatly reduced temperatures of the solutions, there is no need to operate exhaust fans. In one installation, the change to Cold Bonderite eliminated the need for replacing a $15,000 exhaust system.

Water use is reduced about 25% because there is less evaporation.

Maintenance costs nosedive with Cold Bonderite System in the finishing line. Lower temperatures in the heating coils mean less frequent—or no necessity for—cleaning the coils. When there is service to be performed, the maintenance crew can move right in without waiting for the installation to cool off.



Comparative 48-hour salt spray test proves performance. Left, untreated panel; right, panel Cold Bonderite-treated before painting.

One user figures that he has eliminated 364 manhours of maintenance time yearly with his Cold Bonderite System.

The same manufacturer has discovered, too, that the reduced temperatures have allowed him to eliminate a number of steam traps and steam coils costing over $8,000.

Coating Quality Is High

While Cold Bonderite System is saving money on the phosphating line in these many ways, there has been absolutely no diminution of quality in the coatings or their performance.

The Bonderite coating produced by low-temperature Cold Bonderite System matches the high standards set by Bonderite for thirty years. In salt spray, humidity and outdoor exposure tests, as well as in actual service on automobiles, appliances, furniture and many other products, performance has been proven.

Results are uniform hour after hour and day after day. Control and operation of the system is simple and practically foolproof.

Chemical Costs Held Low

All the savings attained by the use of Cold Bonderite System are *real* savings. They show up on the P & L statement because *chemical costs for this revolutionary development are not increased.* The special Bonderites and Parco Cleaners are strictly comparable to conventional hot treatments in the cost of treatment per square foot.

Only Parker Has Cold System

There is, actually, no other system like it. Cold Bonderite System was developed by Parker research, tested and perfected by Parker chemists. It has been proven over and over again as the way to get superior phosphate coatings on steel with spectacular savings.

The Parker representative in your territory is ready to advise and work with you to change your phosphating installation over to Cold Bonderite System. Call him in or write direct to Parker, Detroit.

**Bonderite, Bonderlube, Parco, Parco Lubrite – Reg. U.S. Pat. Off.*

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2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

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Increasing Government-Sponsored R & D Creates Patent Policy Problems

WASHINGTON—US government patent policies, in the words of one high-ranking patent official, are "a mess." And with the federal government now financing more than half the research in this country, agitation for a general overhaul of the system is increasing on Capitol Hill.

Several moves are already under way:

- The Senate patents subcommittee is in the midst of a study just trying to find out what the policies of the various agencies are.
- One congressman is pressing for a Government cut of the royalties on patents growing out of government-sponsored research.
- The new space agency has issued a set of regulations, generally opposed by business, which may mark a new pattern in federal patent policy.

Still two more questions bothering patent officials and congressmen are: (1) whether present policies are fostering or hindering commercial development of the by-product of government research; and (2) whether the government is hastening the death of small business by encouraging big business dominance through patents.

Most of the experts agree that a uniform government policy is needed, and that it should be fixed by Congress. But what the policy should be starts a number of arguments.

GOVERNMENT DOMINATES R & D FIELD

Within the past 10 years federal expenditures on research have jumped from $1 billion annually to more than $5 billion—with $3.5 billion for the Defense Dept alone in the 1960 budget. Private industry altogether spends only $4 billion on its own research.

Many of these government contracts yield patents which have considerable commercial value. Examples: transistor and resistor improvements, better computers for ICBM control, heat-resistant alloys for nose cones which also can be used in engines, low-temperature experiments in space navigation that apply to the refrigeration or chemical industries. Lithium hi-temperature grease for airplanes was developed by the Navy. Household spray cans grew out of Agriculture Dept research. A number of commercial radar patents are by-products of government contracts.

The Defense Dept, the biggest dispenser of research money, allows a company to keep any patents it develops, except for free use by the government. Many people have asked why the US does not at least recoup its research costs by taking a cut of the commercial royalties. The British government has been doing this since the turn of the century. The Vickers Viscount, developed under government contract, has returned enough to the British Treasury to pay off the original research cost and yield a profit. Jet engines have been a profitable venture for the Exchequer. Capt George N. Robillard, the US Navy patent chief, has been a supporter of the British method for a long time, and Rep Frank Thompson (D-NJ) has introduced a bill to adopt the British system here.

Meanwhile, a firm doing extensive research for the government is confronted with a variety of policies. The Defense Dept is liberal with patents; the NASA is stricter; and the AEC is stricter yet. Since many contracts cut across several agencies, the contractor may be dealing with half a dozen different patent attitudes on the same project.

The economic impact of present policies has had very little attention, and no real studies have been made. The Defense Dept feels commercial exploitation is most likely if one company has patent rights. The Tennessee Valley Authority feels differently and has always made fertilizer patents available to everybody. This posed the question: Would the government have to pay more for research contracts if companies did not have the added temptation of a possible killing on the side? Answers to this and other questions are vital to any new legislation on the subject, and some critics feel that the Senate Patents Subcommittee, instead of merely cataloguing present policies of all the various agencies, could spend its time more profitably on these questions.

The report is that excessive channeling of research contracts into big business is causing considerable worry. Big business (over 500 employees) gets at least 95% of the government research, and 100 firms get 85% among them. The top 14 companies getting contracts between 1954–56 were all big electric and aircraft companies. The Attorney General has warned that channeling all this patent potential into big business is just building up the monopoly trend.

The House Small Business Committee recently spoke of "the ominous shadow cast on the future with the monopoly of technology by big business." Small business, say its supporters, helps foot the government research bill and should at least have access to patents developed at the taxpayers' expense. The big contractors reply that it is their reservoir of know-how that makes research successful.

THE NASA EXPERIENCE

Policy makers, meanwhile, are watching the experience of the new space agency with its relatively "tough" patent provisions. NASA retains patent rights if an invention applies primarily to defense projects. But if it has only incidental use for NASA and "substantial promise of commercial utility," NASA will let the company keep title and collect royalties on the condition that they develop the product commercially within five years.

Big NASA contractors have complained about the time-consuming process of getting formal permission from the agency to keep a patent. One contractor, for instance, developed a course director of no use to NASA but useful for blind flying of small private planes. He complains that he cannot get a patent until he proves either that it is primarily of commercial use, or that it was not developed primarily under a government contract.

NASA's patent chief, G. D. O'Brien, says the agency has actually had no difficulty placing contracts once officials have had a chance to explain

patent provisions to bidders. "While they may hesitate at first," O'Brien says, "in no instance have they refused in the end." NASA prefers to let the company keep patent rights because it can impose the five-year condition. If the patent were offered to everybody, no one would have the incentive to go into production, NASA believes.

LAWYERS BACK INDUSTRY

The American Bar Association backs industry's stand against the NASA pattern. Patents are an incentive to inventive genius, they say, long recognized in the free enterprise scheme of things. Others argue that corporations themselves do not generally let individual scientists keep patent rights, so the incentive factor is already destroyed at the creative level. A Senate patents subcommittee, in a study by Prof Seymour Melman of Columbia University, concluded that companies have enough other incentives, such as development of know-how, to keep them interested in research even if there were no patents.

Several big corporations have asked the House Space Committee to hold hearings on NASA's policies. But the Committee will probably wait until next year when business has had a chance to live with the policies for a reasonable length of time.

Ultrasonics Bonds Aluminum

PITTSBURGH—A technique for bonding aluminum foil with ultrasonic vibrations has been developed jointly by Aeroprojects, Inc of West Chester Penna and Aluminum Co. of America. The technique is being applied to joining ends of aluminum foil rolls at the Alcoa plant here.

The Aeroprojects unit joins two pieces of foil by subjecting them to 50,000 cps vibrations. Such vibratory energy fractures the oxide film on the foil causing the metal to flow together to form a metallurgical bond less than $\frac{1}{8}$ in. wide. The bond is almost as strong as the parent metal.

Because of the new ultrasonic bonding equipment, consumers will be able to get material in long, continuous strips without the heavy splice areas produced by heat-sealed adhesives.

Foresee Rise in Red China Heavy Machine Tool Output

LONDON—The Chinese are making a prodigious effort to enlarge their capacity for producing heavy machine tools. A new plant at Wuhan is indicative of both the size and variety of equipment now in production, according to experts recently returned from Peiping.

Located at the junction of the Peking-Wuhan and the Canton-Wuhan railroads, which now for the first time are connected by a bridge across the Yangtze river, the Wuhan plant lies at the center of China's second largest iron and steel area. Already ahead of schedule, this plant, the Chinese say, was expected to start producing in 1960 and to reach its maximum annual capacity of 380 machine tools in the 20 to 160 ton class by 1964.

Actual production is reported well ahead of schedule, having begun in July of last year. By the end of the year, the plant had turned out 218 machines in the 11 to 78 ton class, as well as smaller machines, pile drivers and castings. This year's target calls for 1000 machine tools.

The factory employs 10,000 workers and staff in a highly mechanized plant. The labor force—30% women—works in two shifts.

Original plans called for production of 17 different types of machine tools when the plant reached capacity in 1964. During 1958, Wuhan turned out 11 different types of tools in-

Huge concave dish . . .

Goodyear Aircraft has designed and phased into production this 84-ft dia antenna dish with a supporting pedestal equal in height to a 3-story building which comprises tracking radar antenna assembly and radome for the Air Force Missile Early Warning System. Pedestal and antenna weigh about 375,000 lb. Protective radome will be large enough to encircle a 2-story house on a 100-ft lot. Its 6-in thick walls are made of paper pressed into honeycomb design and faced with plastic-impregnated fiberglass.

cluding a 3-meter planing machine. And it presently has in production a 5 by 20 meter universal lathe weighing 400 tons, a vertical lathe with 16 meter dia table, a 12½ meter hobbing machine, a boring machine with 320 mm dia spindle and a 6-meter planer.

Chinese personnel helped design the $70 million plant that was built with Soviet assistance. A few Soviet aides are still at the plant, though the number is dwindling. A large portion of equipment for the plant was made in China, with the rest imported from Russia and Czechslovakia. One machine, a 300-ton Soviet press is very rare.

This Wuhan installation is not a one-shot affair. Four plants with roughly the same capacity are under construction from the same blueprint. These later installations are being implemented largely by the Chinese. An even larger plant is also in existance at Fularki in north-west Manchuria for producing heavy machinery exclusively.

Such data suggest that the cost and construction time for many machine tools is less at Wuhan than in the United Kingdom. The data also suggests that the Chinese are approaching the West in capability of turning out certain types of machine tools. The Chinese readily concede that they lag behind the West in precision tools and gear production machinery.

Nevertheless, plants at Harbin and Shanghai are manufacturing adequate measuring instruments. **—Peter Trippe**

Seek Common Language for World's Machine Searching, Translation

CLEVELAND—An effort to coordinate international developments in the field of machine searching and translation of scientific and technical documentation into a common language will be made during a conference, sponsored by Western Reserve Univ and Rand Development Corp here, Sept 6 through 12. Papers will be presented by documentation scientists from US, Russia, England, France, Italy, Holland, India, Japan, Brazil and perhaps Yugoslavia, Poland and Czechoslovakia.

Conference aims include: (1) encouraging an environment for working toward a common machine language or a series of compatible machine languages for processing scientific and technical literature so that it may be searched, selected, correlated, and translated by automatic equipment; (2) characterizing equipment requirements for use with common language systems or with compatible machine languages; (3) creating an environment in which it will be possible to foster agreements for cooperative processing and exchange of encoded materials for machine searching of the world's scientific literature; (4) working toward initiating cooperative collection and analysis of scientific and technical terminology for preparation of dictionaries and thesauri for code establishment for use in machine searching and machine translation; (5) promoting cooperative research programs and free exchange of research materials; (6) reviewing interrelationships between machine literature searching and machine translation and to consider how progress in one field may advance the other. **—Allen Kent**

Predict Home Owner May Someday Sell Power Back to Utility Companies

MILWAUKEE—The tantalizing prospect that electric companies may someday buy rather than sell power to American homes was offered by Dr. Lawrence J. Giacoletto, manager of Ford Motor Company's Electronics Dept to the Engineers Society here.

The feasibility of collecting solar energy to generate electricity is presently handicapped by lack of a means for storing power, Dr. Giacoletto said. A possible solution is to turn excess electricity back into utility company power lines for use by industry. This excess could be credited to the residential customer. Already meters that measure home consumption work two ways, both adding and subtracting kwh of energy that pass through.

A 30 x 30-ft roof with a bank of semiconductor solar cells in the Chicago-Milwaukee-Detroit area could generate three times greater than normal home requirements. For the customer, this represents a net return of about $200 a year, Dr. Giacoletto calculated.

When applied, a semiconductor conversion cell would drive a dc motor that could be mechanically coupled to a 60-cycle alternator, connected directly to power lines.

NASA Activates Space Group

WASHINGTON—The National Aeronautics and Space Administration has appointed a working committee to conduct long range explorations of the moon's surface and environment. Headed by Dr. Robert Jastrow of NASA, the nine-man group will superintend experiments and correlate projects for forthcoming satellite and space probe packages.

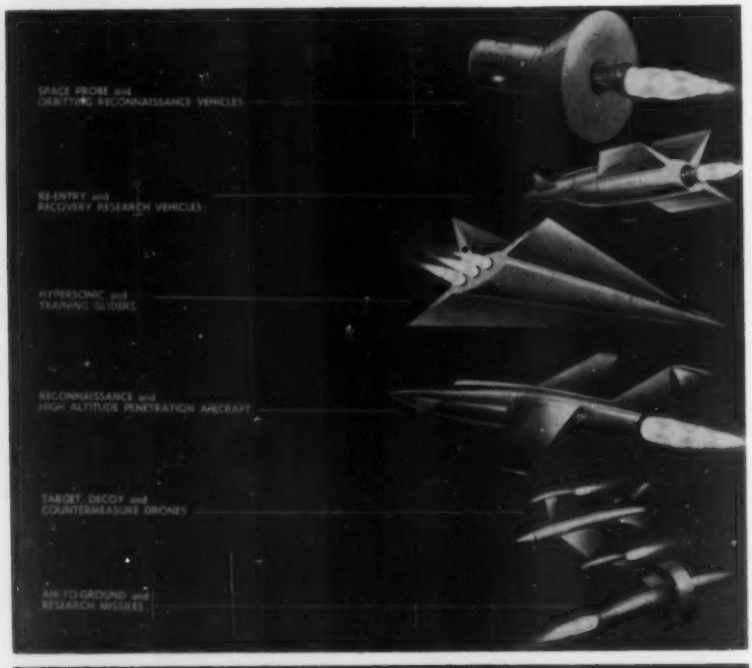
Among the experiments Dr. Jastrow's committee foresees are payload packages to obtain information on lunar environment, satellites to orbit the moon, instrumented packages with sturdy equipment to land on the moon, and eventually instrumented packages with delicate instruments to land on the moon.

Accepting membership with Dr. Jastrow are Dr. Harrison Brown and Dr. Frank Press of Calif Inst of Tech, Dr. Maurice Ewing of Columbia, Dr. Bruno Rossi of MIT, Dr. Herbert Friedman of Naval Research Labs, Dr. A. R. Hibbs of Jet Propulsion Labs, Dr. James Heppner of NASA Space Science Labs and Dr. Herman LaGow of NASA headquarters.

Study Nonnuclear Uses

COLUMBUS, OHIO—Nonnuclear uses for uranium are being studied by Battelle Memorial Institute under an AEC contract (see *PE, July 28, '58, p. 12*). Cost is a major factor but possible applications might include high-density balancing weights for aircraft, missiles, automobile wheels, watches, additives for ferrous and nonferrous alloys and others. Contract calls for new, improved, or potential uses of the metal.

Suggest Upgrading Transport Planes as Role for Rocket Engine


SPACE PROBE and ORBITING RECONNAISSANCE VEHICLES
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TARGET, DECOY and COUNTERMEASURE DRONES
AIR-TO-GROUND and RESEARCH MISSILES

TACTICAL and STRATEGIC BOMBERS
TACTICAL STRIKE and INTERCEPTOR AIRCRAFT
TRANSPORT TYPE AIRCRAFT
COMBAT SURVEILLANCE and TACTICAL MISSILES
HIGH SPEED RESEARCH and DEVELOPMENT SLED
SUBMARINE-TO-AIR and SUBMARINE-TO-GROUND MISSILES

From Underwater Missiles to Space Probes . . . auxiliary rocket engines answer a need. Test flown in the FJ-4F, the Rocketdyne throttleable engines increased the operational ceiling by 1/3 and boosted high altitude speed by 40%. Successful start record—prime importance to commercial aviation—100%.

Los Angeles—Range, short-field performance, load-carrying ability and safety could all be improved in the operation of commercial aircraft through the use of small rocket engines as auxiliary propulsion units according to engineers of the Rocketdyne division of North American Aviation.

Some modification to the user-aircraft would be needed, additional terminal facilities for handling high-strength hydrogen peroxide—one of the propellents used—would have to be installed, and an extended period of further testing to win FAA approval would also be necessary. However, work that has already been done in this country and abroad indicates that the use of such engines is economically feasible and—if maximum use is made of the potential increase in performance—could return a profit within a very short period.

Since all commercial planes are, in effect, carrying surplus power that is needed only during takeoff and steep climbs, proponents of the rocket auxiliary suggest that this source of dependable thrust would permit increased payload that would take full advantage of the available power. This would increase the revenue of the piston-powered cargo and passenger planes, and the newer jets that must limit passengers to meet the steep climb specifications to minimize jet noise in residential areas near airports. Engineers indicate a 50% decrease in takeoff run or a 30% increase in payload with a 60% rocket to standard engine thrust ratio.—**Jack Meyer**

More Canadian Engineers Hired by Boeing as Consultants to Bomarc

Seattle—Boeing Airplane is negotiating with de Havilland Aircraft of Canada Ltd for use of Canadian engineers on a consulting basis. The Canadians would assist Boeing's applied physics staff in the study of the application of advanced electronic techniques to the Bomarc System. Previously, some 180 Canadian engineers were used by Boeing under terms of the same consultant contract.

V-belt Ratings Tripled by Stress Analysis Technique

DAYTON—New V-belt horsepower ratings that show 20 to 115% increases over old ratings have been developed under recent research carried on jointly at Dayton Rubber Co and Ohio State Univ. The new ratings are based on a scientific method of analyzing stresses induced on components and their effect on expected life.

During an exclusive interview with Dayton Rubber Co engineers and Prof S. M. Marco, chairman of Ohio State's Mechanical Engineering Dept, PRODUCT ENGINEERING learned that laboratory tests and field data covering more than 1 million hours of operation involving all types of belts went into the new ratings.

Their research indicates that:

- Increase in horsepower is achieved through increase in the permissible value which reflects the increased tensile strength of the belts resulting from stronger cord materials, new rubber compound formulations and improved belt fabricating and curing techniques.
- If the same horsepower per belt is desired as with the old ratings, increased belt tension can be accompanied by a decrease in sheave diameter (D), or angular speed of the sheave (n).
- In multi-belt drives, normally used where large forces must be transmitted, the same horsepower transmission as with the old ratings can be obtained with narrower sheaves, fewer grooves and belts. Total tension load, of course, must be the same, but it is now redistributed over a smaller number of belts as each is able to carry a larger load than before.
- Or a combination of changes may be introduced whose cumulative effect does not exceed the values of these factors.

These theoretical possibilities are somewhat reduced in practice by the standardized ranges of commercially available sheaves. Whether these, too, will undergo a change to reflect the new belt ratings is not known at present.

The new analytical methods establishes a relationship between belt structure and size, horsepower, size of pulleys and life of the belt, according to Prof Marco and Prof W. L. Starkey of Ohio State and K. G. Hornung, research engineer for Dayton Rubber Co.

L. J. Confer, manager of the belt engineering department at Dayton Rubber pointed out, that first low cost as compared to minimum operating costs are considered in design of V-belt drive. The preference for low first cost frequently leads to minimum diameter of sheaves and shortest center-to-center distance when space limitations do not dictate otherwise.

The new ratings effectively reduce the gap between these extremes. They reflect gradual and cumulative improvements in the properties of cords, in the compounding of the rubber, and in the techniques of fabrication.

Confer also said that Dayton, like the rest of the industry, presents belt data and ratings only as a guide to engineers in designing transmissions with no life guarantees expressed or implied.

Powder-metal Bars—Made Thicker

DETROIT—A new method for continuous compaction of metal and ceramic powders was described in a paper delivered by F. Emley and C. Deibel of Westinghouse's East Pittsburgh, Penn, materials engineering dept at the recent annual meeting of the Metal Powder Industry's Federation here.

The process, described as continuous compaction and based on tests conducted on laboratory scale, is said to be capable of producing bars of unlimited length, relatively large cross-sectional area, and thicknesses of more than 1 in. (1-in. max thickness was obtained in the lab project). This applies to bars of copper, iron, titanium sponge, columbium, tungsten, and molybdenum.

Newly compacted or "green" bars can be sintered immediately in a continuous process, and can also be subjected to further densification steps.

Process is said to overcome present size limitations of compacting-sintering methods of producing individual structural parts. This is also true of slip casting procedures and extrusion.

(Continued on page 20)

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Cutaway view of TRE Male Rod End.

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Also, it may result in greater speeds and considerably greater thicknesses than roll bonding of metal powder into strip. However, the new Westinghouse process can produce thicknesses comparable to that obtained from roll bonding, as small as 5 to 10 thousandths.

Compacting loads ranged in lab studies from 15 tons to 100, depending on material and width being pressed. Sintering practice is typical of present-day methods. Sintered density was 90% for copper powder, 94% when repressed; RZ iron, 71%; Kovar, 62% (89% when repressed). Uniformity of dimensions and density seem to be easily obtained.

—Jack Kolb

Designers to Meet in Philadelphia

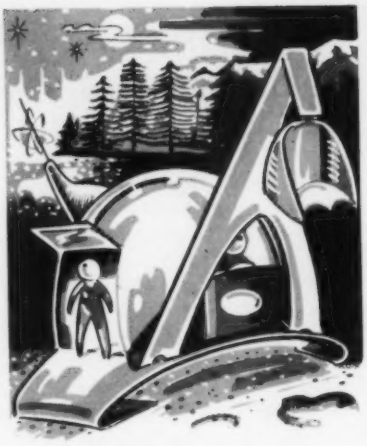
NEW YORK—The ASME's 1959 Design Engineering Conference will assemble at Convention Hall, Philadelphia, on May 25-28, and will run concurrently with the Design Engineering Show to be staged by Clapp and Poliak, Inc.

The opening-day conference session will consider the philosophy of design engineering in foreign countries with Hellmuth Walter, director of research, Worthington Corp, delivering a paper on design in Germany. Freedom of designers to design as they believe as contrasted with design influenced by sales and marketing, will be discussed at the conference.

Four days of technical sessions at the Conference will cover varied phases of design including materials, power and control, mechanical engineering, and engineering organization and the man.

The wind-up session on engineering department organization will offer papers by E. M. Ramberg, vice-president of Engineering Titeflex, who will analyze organizational shortcomings in the small, medium and large firm, and the vice-president and director of Psychological Services of Clark, Channell, Inc, Martin M. Bruce who will suggest organizational structures that meet the needs of management and the individual.

Materials sessions will treat plastics, metals and ceramics for 1000 F environments and where corrosion resistance is required. Power and control sessions will highlight digital systems and logical circuits for controls.



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Develop All-purpose Motor as Teaching Aid

CAMBRIDGE—The electrical engineering labs of 150 colleges throughout the US are now getting a novel general-purpose motor-generator combination as a teaching aid. The unit, developed by Professor David C. White and Herbert H. Woodson at MIT, accompanies a text book, Electromechanical Energy Conversion, that the MIT professors published in January.

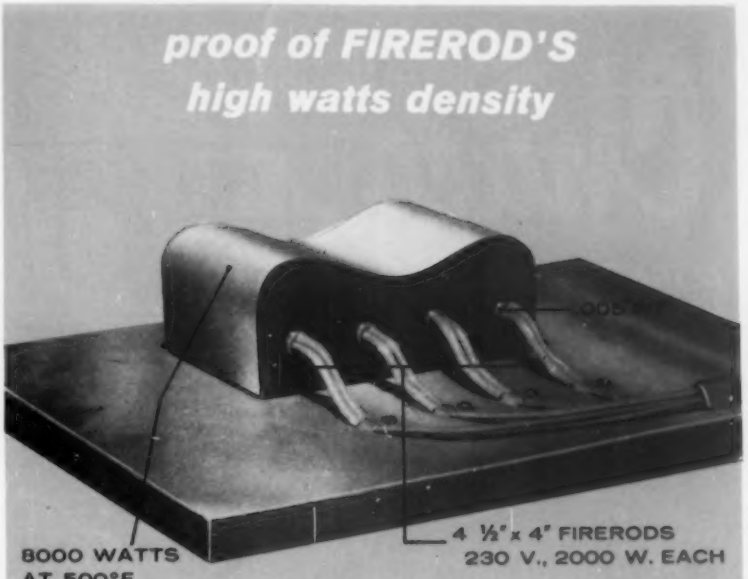
MOTOR-GENERATOR ADVANTAGES

The generalized motor-generator can be wired by students to simulate all types of motors—ac, dc, induction, etc. It includes a two-phase stator, a conventional type rotor, two sets of brushes, and a rotor brush carrier. Auxiliary equipment includes a motor to drive the rotor and brush carrier. Included also are a tachometer and torquemeter for measuring shaft and brush speeds. This motor-generator will assume the characteristics of the various electrical motors depending on how the lab student wires it.

The motor-generator combination has two major advantages, Professor White points out. Inclusion of the tachometer and torquemeter now permits students to make dynamic measurements. For the colleges, the unit has the advantage of being small and flexible, hence it takes up less lab space. MIT will be able to reduce its machine lab area from roughly 75 by 100 ft to 15 by 50 ft when its eight machines are installed.

CURRICULUM CHANGE

Professor White and Dr. Woodson developed the motor-generator as part of a basic alteration in the electrical engineering curriculum. Under the revised curriculum, the student will get a more generalized approach to electrical engineering. Work on the program began about six years ago on a grant to Professor White from the General Electric Educational and Charitable Foundation. About a year and a half ago a National Science Foundation-sponsored meeting drew together representatives from 100 engineering schools to consider the new curriculum. At the NSF meeting the Westinghouse Educational and Charitable Foundation agreed to manufacture the motor-generator and donate it to the 150 schools.



FIREROD Cartridge Heaters
...rated at 370 watts per square inch in steel die heated to 500°F.

FIELD PERFORMANCE clearly reveals the Firerod's exceptionally high concentration of heat. For example:

Four Firerod units, ½" x 4", wired in parallel and operating at 500°F. in a steel die measuring 4" x 6" x 2", can be rated at 370 watts per square inch. This means a rating of 2,000 watts for each unit which means more parts can be processed per hour. By comparison, a standard unit should not be rated much beyond 120 watts for the same application, without danger of immediate burnout.

THIS PERFORMANCE IS POSSIBLE BECAUSE of Firerod's special method of manufacture. The close proximity between resistance wire and heater sheath permits maximum heat transfer. The result is faster heat, higher temperature potential, greater watts density and longer operating life.

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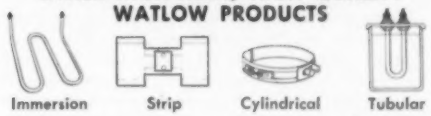

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Chace Thermostatic Bimetal is available in coil, strip and in completely fabricated and assembled elements of your design. For a thorough indoctrination in the subject and engineering and design data second only to our consulting service, send for our booklet "Successful Applications of Chace Themostatic Bimetal."

IT BENDS WITH THE HEAT

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New Flame-resistant Urethane Foams

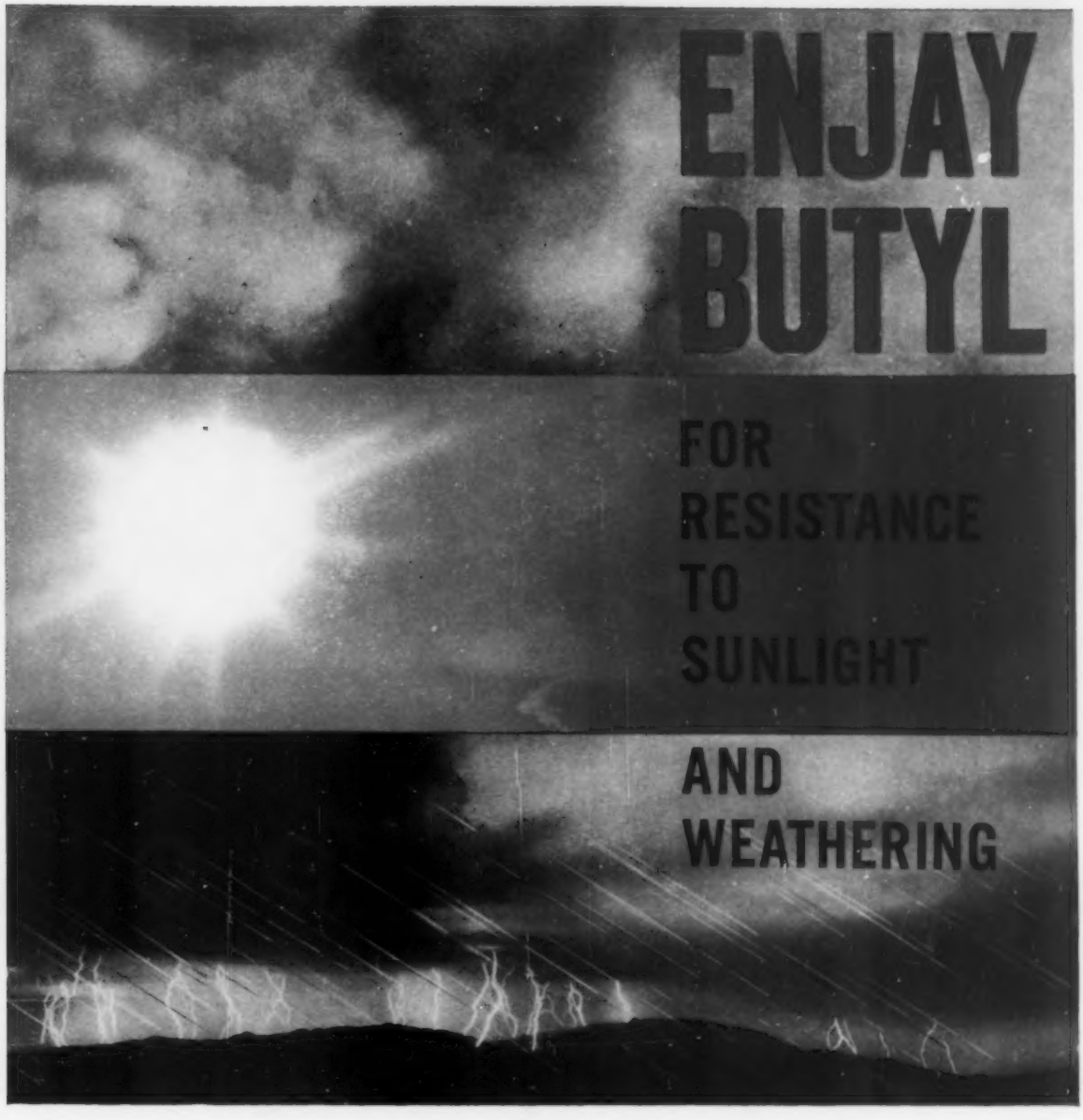
RICHMOND, VA—Experimenting with the ingredients of fertilizers has led the Virginia Carolina Chemical Corp to a method of adding flame-resistance to the unusual properties of urethane foams. The V-C technique incorporates 1-2% phosphorus into the chemical structure of urethane foams, flexible and rigid, to make them completely self-extinguishing. This approach differs radically from the present technique of adding a carrier retardant to the system. Principal advantage appears to be flame-resistance at no additional cost, since the organic phosphorus compound is one of the reactants and thus replaces part of the conventional ingredients. Preliminary data on urethanes made with phosphorus show a slight lowering of thermal conductivity over conventional types and no influence on foaming characteristics or on mechanical properties. Both polyester and polyether foams in the flexible family can be made with phosphorus, but so far only the polyesters in the rigid family can be so formulated. Major impact of the new technique appears to be in thermal insulation applications where fire underwriters are taking a closer look at all foams.

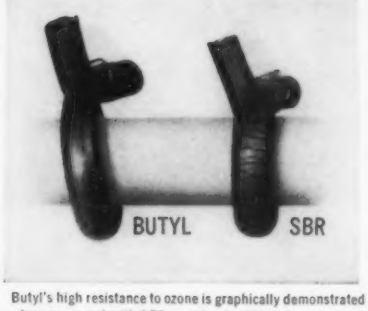
Issue New Engineer Drawing Spec

WASHINGTON—A new uniform engineering drawing specification that will reduce the variety of requirements military contractors must meet has been issued by the Dept of Defense.

Titled "Military Specification Drawings, Engineering and Associated Lists," and numbered Mil-D-70327, Mar 16, 1959, it replaces 158 old specifications formerly used in the procurement of drawings. Previous standards now part of Mil-D-70327 include Mil-STD-15 (electrical and electronic symbols); Mil-STD-103 (abbreviations for electrical and electronic use).

Specification adds, however, that "existing drawings, lists, standards, etc, which do not entirely comply with the requirements of this document may be acceptable if they contain the necessary technical data required by the procuring activity, and are identified by code in accordance with Mil-STD-31."





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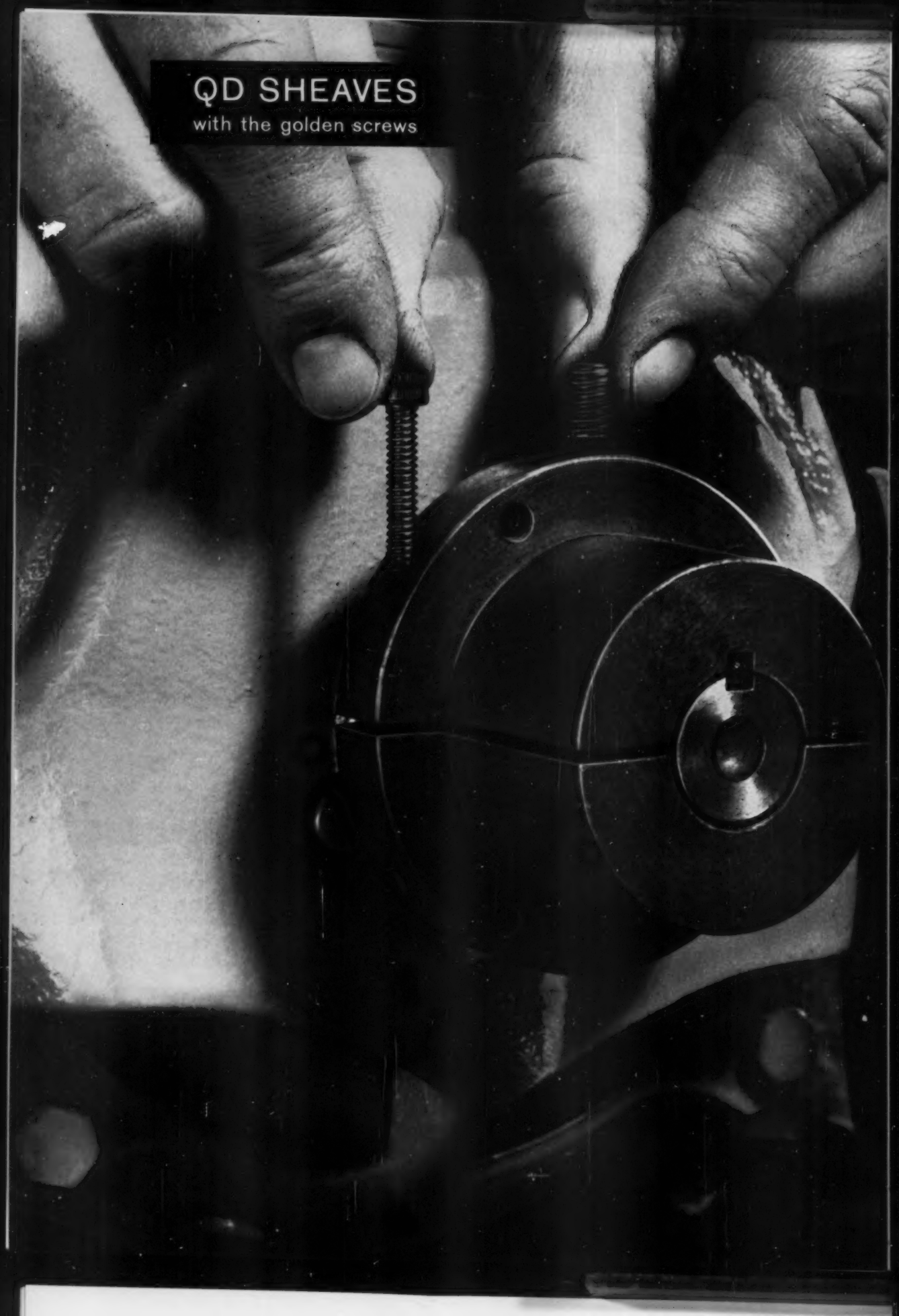
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with the golden screws

Announcing
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with the

GOLDEN SCREWS

Golden screws? That's right. All Worthington QD (Quick Detachable) sheaves now have two golden screws. Worthington has a reason for doing this: to demonstrate to you that the exclusive two-screw design is practically worth its weight in gold. These extra two screws are the big difference in sheaves.

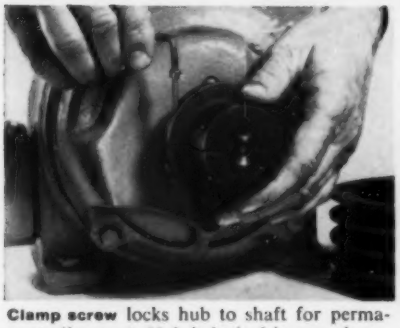
The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves *one part at a time*. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another sheave on the hub which remains anchored to the shaft by the clamp screw.

The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

You can get Worthington QD sheaves anywhere in the U.S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pa. In Canada: Worthington (Canada) Ltd., Brantford, Ont.

WORTHINGTON



Clamp screw locks hub to shaft for permanent alignment. Hub is locked in one piece—*no distortion* as set screw is drawn down.

Set screw locks key in place, prevents "key drift," a necessary safety feature.

Pull-up bolts lock the sheave rim to the hub.

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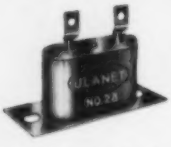
Ulanet Thermostats Value Continued Material Uniformity in TRUFLEX parts and assemblies



Model 28 Miniature Hermetically Sealed Thermostat extremely sensitive.

Here's another case history of a leading manufacturer who has found he can depend on parts made from General Plate's TRUFLEX thermostat metal. H. Ulanet, President of the George Ulanet Company, puts it this way:

"Bimetal is a most important component in Ulanet Thermostats which have a world-wide reputation for quality. Therefore we must be certain of continued material uniformity and quality with each shipment.

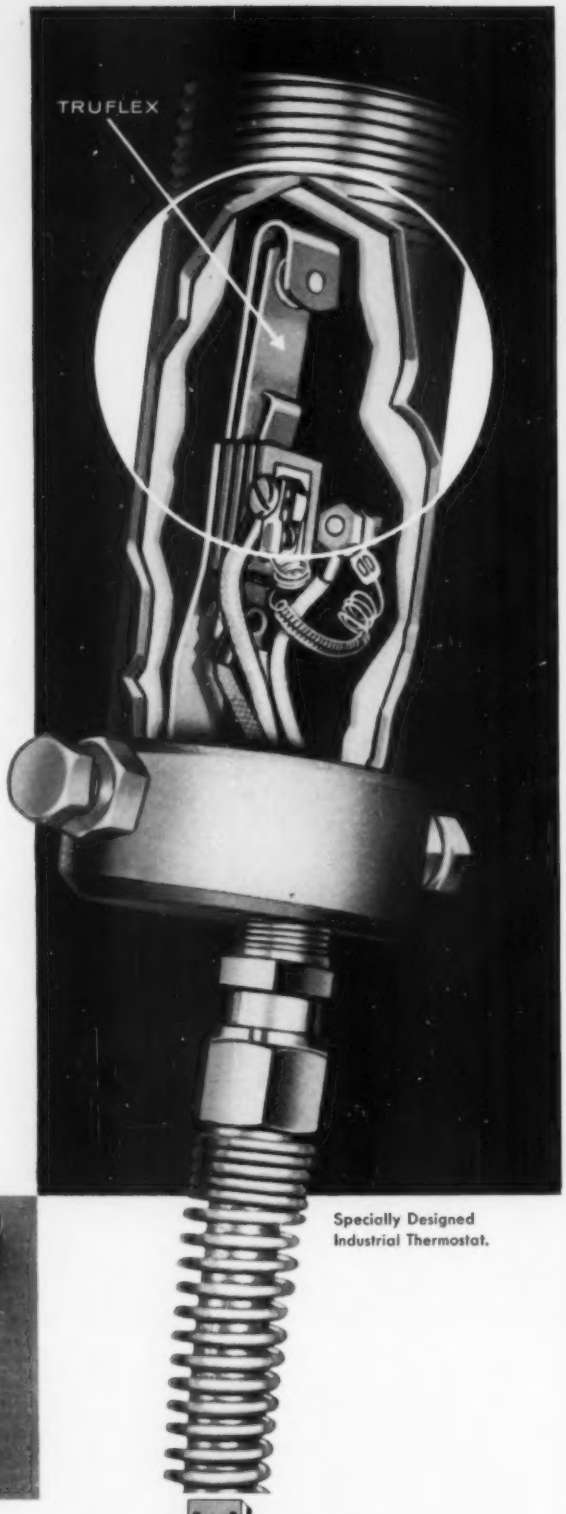
"During our 22 years' experience with General Plate's TRUFLEX *thermostat metals we have found that they have met our exacting specifications."*

General Plate can supply dependable thermostat metal parts and assemblies for installation in your products, too. You'll get top performance because the high quality of each piece you receive is consistently uniform — an exact duplicate of the original.

General Plate TRUFLEX thermostat metal parts and assemblies are made to meet your specific needs for temperature range, electrical conductivity and corrosion resistance.

If you set up to make your own parts, General Plate can supply TRUFLEX thermostat metal strip to consistently meet your specifications. Send us your specifications for parts or strip — we'll be pleased to quote.

A few typical Truflex formed parts and sub-assemblies.



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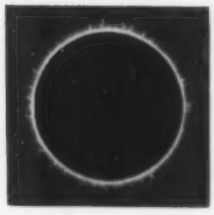
Product Engineering

HORIZONS

May 4, 1959

at the edge of the unknown . . .



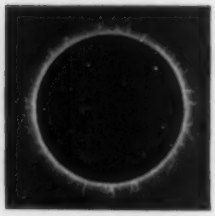
When you think of it, man is a foolhardy creature. The human body is a fairly delicate mechanism. It can, for short periods, move unaided at 15 mph or deliver ½ hp. It can withstand a 200 F temperature range, a 2-mile altitude range, limited light, sound, vibration and atmospheric variation.

Consider, then, the temerity of engineers who plan to send that mechanism through several thousands of degrees of temperature change at tens of thousands of miles per hour to a visible but unknown destination with an estimated atmosphere. Only a few years ago, this was a madman's—or a romantic's—dream; now we're betting national futures on it.

Two *Product Engineering* editors have ventured into the unknown, not so much that of science fiction and outer space, but into practical products and the inner space of man's planning for his own earth-bound existence. As one of them put it, they've gotten into the areas "where what we know, guess and imagine is well mixed with blind ignorance." They probed at possibilities in power and energy sources, at thinking machines, calculation and communications. They dared to forecast where tomorrow's products are coming from and what they will incorporate.

Their forecasts have been checked by other editors and by some outsiders. They appear in succeeding pages. How do their ideas check with your own?

R. T. Langeman



at the edge of the unknown . . .

TAMING TOMORROW'S POWER SOURCES

Nuclear and solar power
Ions, photons and free radicals
—theories today
engineering tomorrow

ANNESTA R GARDNER
associate editor

It has been many years since a new major power source appeared on the horizon. Solar energy has been discussed—and even used—for centuries. Fission and fusion power were both known, though unharnessed, 20 years ago.

But, if there are no new sources, there is tremendous progress in utilizing existing sources.

Today, there is talk of creating new sources of hydroelectric power—new dams and waterfalls—by nuclear explosion. Plans are being laid for large-scale utilization of solar energy to de-salt the seas. New work is even being done on windpower. Baby windmills are being developed for such applications as boosters on remotely located telephone lines (*PE*—Nov 4 '57, p 5). Considerable thought is being devoted to tapping natural heat sources—particularly the great heat of the earth's core, via man-made hot springs or lava streams.

Research is well under way on such advanced systems as ion and photon propulsion. And, for the first time, there is hope that the mystery of gravity may be unlocked, to reduce the need for power if not to provide new sources.

fission and fusion

In the nuclear-energy field, there is, of course, a tremendous amount of activity. But even the most "conventional" fission reactors are a long way from being standard designs. The one big plant now in operation (at Shippingport, Penna) and those being built for New York and Chicago, had to be designed without operating data from previous plants to serve as a guide. Only now such data are beginning to be collected at Shippingport. No wonder, then, that there have been troubles and delays and that "cheap power from the atom" is a long way off.

This applies to fusion power even more strongly. The fact is, we have yet to create a sustained, controlled release of fusion energy—much less one that produces more power than it consumes. Yet there is much hope for fusion power in the future. Fusion is potentially a simpler and more efficient system than fission.

In the fission reactor, energy is produced by breaking up big, heavy atoms—releasing energy in the form of heat and neutrons which are used to keep the reaction going. (Neutrons are the "projectiles" by which the breakup is accomplished.)

Fusion, on the other hand, is the joining together of atoms—this time, small, lightweight ones; again, with release of energy. All that's necessary is to bring atomic nuclei close enough together so they'll bump and fuse. But producing a controlled, self-sustaining fusion reaction on order is not such a simple matter.

The lightweight atoms are available. Heavy hydrogen (deuterium) or H^3 (tritium) may be used. But they must be heated to exceedingly high temperatures to get them to move fast enough so they'll bump hard enough to stick together; and a way must be found to contain these hot,

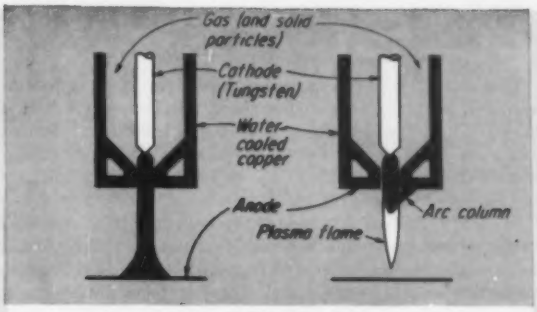
HOW PLASMAS ARE MADE

First step to fusion power is finding a way to create and contain the hot, ionized gases or plasmas in which nuclear fusion may occur. For a power-producing reaction, it is believed temperatures of 50 to 100 million C will be needed. But, to demonstrate thermonuclear activity, temperatures in the 10-million-C range will suffice. Creating them is actually not as difficult as it might seem. It can be done by extending the techniques that create the 10,000- to 30,000-F plasmas now used for welding, cutting, and hard-surfacing. Here an electrical discharge, across an electrode gap through which the gas flows, will do the trick. Conventional power sources are used. With a 500-amp current and a voltage of 100, an arc jet of 50 kw can be delivered through a nozzle at an average gas temperature of 10,000 to 15,000 degrees Kelvin. Power concentration ranges about 3-mw/sq in.

Controlling the arc and the flow of hot gas has called for ingenious engineering (see diagrams).

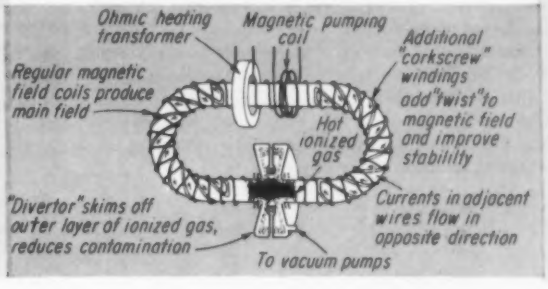
For temperatures in the million-degree range, current pulses in the order of 200,000 amps are needed. This calls for king-size equipment. But basically the approach is conventional. High-current pulses from banks of capacitors are used to "preheat" the gas to about 100,000 C. At that point, it is ionized enough to be electrically conductive. Then, with high-voltage equipment, a magnetic field is set up which compresses or "pinches" the gas, serving the dual purpose of keeping it away from the container walls while heating it still further.

At the present state of the art, such "pinch effects"—and such high temperatures—can be achieved only on a momentary basis; but there is hope that bigger units and more efficient design can produce more-stable, longer-term heating.



two types of plasma jet torches . . . are diagrammed here. At left is "transferred" type, in which both arc and gas jet reach the work. At right, is non-transferred type, primarily for plating, in which only the flame impinges on the work-piece. Both are Linde designs.

racetrack stellarator . . . uses elliptical tube to contain plasma. This is a more advanced version of the familiar "Figure-8" Stellarator. With equipment of this type, it is hoped that 5 to 10 million degrees may be achieved.


Ohmic heating transformer
Magnetic pumping coil
Additional "corkscrew" windings add "twist" to magnetic field and improve stability
Regular magnetic field coils produce main field
Hot ionized gas
"Divertor" skims off outer layer of ionized gas, reduces contamination
Currents in adjacent wires flow in opposite direction
To vacuum pumps

fast-moving atoms, to keep the hot gas or plasma from getting away.

For an explosion—a momentary release of energy—the job is not too difficult. Hydrogen explosions have been produced with fission-bomb "heaters." But a controlled, sustained, release of energy from a plasma system (see above) is much more difficult. It's going to take a lot of engineering to produce a workable, full-scale power plant. And, in the end, hot plasmas may not be the only route—or even the best one.

There are other approaches to thermonuclear power. For instance, one reason for compressing or "pinching" the plasma is to keep the hot gas away from the container walls. Another is that energy-producing collisions are far more likely to occur if the atoms can be brought closer together. But there may be low-temperature routes to the same goal.

One low-temperature fusion system, suggested by Luis Alvarez of the U of California, would use a subatomic particle as a sort of nuclear "glue" to bond hydrogen atoms when they are brought together at ultra-low temperatures; and there have been other proposals.

Still, the plasma approach seems the most promising right now, and it is this approach which characterizes the Stellarator and Britain's Zeta and Sceptre units.

ion propulsion

Even without the promise of fusion energy, there are good reasons for studying million-degree plasmas. When we have learned to control hot plasmas, we shall have taken a long step toward the practical application of ion propulsion. This widely discussed system uses electrified particles (ions) as a source of thrust, much as a conventional rocket uses a stream of hot gases rushing through a nozzle. Here, the ion source might be a metal such as cesium (one of the most readily ionized of the heavier elements which are desirable for this type of application) heated to the vaporization point, ionized by an electrical discharge, then propelled by an electrostatic field. Heating might be accomplished by nuclear, chemical or solar means.

A lot of engineering research will be needed to produce a practical ion system; but much progress is being made.

free radicals

There is also a low-temperature route to gas propulsion. This method would use the energy of recombination of free radicals (un-ionized or weakly ionized molecular fragments).

Free radicals are readily produced. Molecules normally

Like most "overnight successes," new devices for converting heat into electricity have a long history of development behind them. This is particularly true of the thermoelectric devices, which are based on the Peltier, Thompson, Hall, and Seebeck effects. Because these effects are so basic, it's worth taking a few minutes to review them:

In 1823, Thomas Seebeck discovered that if a circuit is formed of dissimilar conductors, and one junction kept at a higher temperature than the other, a voltage will be generated between conductors which is proportional to the temperature difference. This is the basis of the thermocouple.

Then, in 1834, Jean Peltier of France found that, if an electrical current is passed through such a circuit comprised of dissimilar metals, heat is evolved at one junction and absorbed at the other. Furthermore, the heat evolved is proportional to the current, and reversing the current will reverse the temperature difference.

Next, William Thompson (Lord Kelvin) predicted—correctly—that heat generation and absorption could take place in a single material if a current were passed through it. In most materials, though, this effect is so slight it is hardly useful. But in the late 1870's, E. H. Hall of Johns Hopkins discovered that if a strip of metal, carrying an electrical current, is placed in a magnetic field, a voltage gradient will be developed across the strip, skewed in one direction or another depending on the conductor material used.

These effects were duly noted and, to some extent, put to work. Simple thermopile lighting and radio-power systems based on the Seebeck effect are, for instance, widely used in the Soviet Union *(PE—July 14, '58)*. But it was not until very recently that a major effort began to use these principles in developing efficient heat-to-electricity converters.

One big break came with the development of semi-conductors, in which Thompson and Hall effects are greatly amplified. Large-scale commercial availability of semiconductors opened the flood gates for dreams of motive power directly produced by conversion of heat to electrical energy, of motorless refrigerators and "electronic" air conditioners, and all sorts of new heat-production and control devices. Today, many of these have passed from the dream to the prototype stage. The solar batteries used in radios, clocks, and hearing aids fall in this category. The Navy has built a thermoelectric public-address system. Bell Labs has a 1.25-watt thermoelectric power-line generator on test, both using gas burners as a primary source of heat. At least a half dozen thermoelectric "atomic batteries" using the heat of decay of radioactive isotopes, have been designed, and some are actually in production.

Now, the talk is of thermoelectric devices in which one of the conductors is not a solid at all; but perhaps a gaseous plasma. Reasoning that the Peltier effect should occur with any two dissimilar conductors, Los Alamos scientists have begun to experiment with a converter in which one element is a metal, but the other is a hot, ionized gas (see p. 11).

thermoelectric principles . . .
are outlined by these Office of Naval Research diagrams. In each case, temperature differential between two materials makes it possible to create an electrical output.

dissociate in the process of chemical reactions. The trouble is that, under normal conditions, dissociation and recombination occur so rapidly that it is not possible to store or direct the energy produced. To put free radicals to work, some way must be found to trap and hold them until their energy is needed. Cryogenics, the science of ultralow temperatures, may provide the key. Scientists at the National Bureau of Standards have demonstrated *(PE—Oct 7 '57, p 15)* that free radicals, produced by electrical discharge, can be captured on a quartz plate held at cryogenic temperatures in a liquid helium bath. Then, when warmed slightly, they will release their energy. Taking off with such a system at the present time would require a tremendous amount of auxiliary equipment—cryostats to produce and store the liquid helium, electrical sources for the ionizing discharge, and a gas-storage and handling system for the free radical source. Still no one is ready to label the idea either outlandish or impractical.

photon propulsion

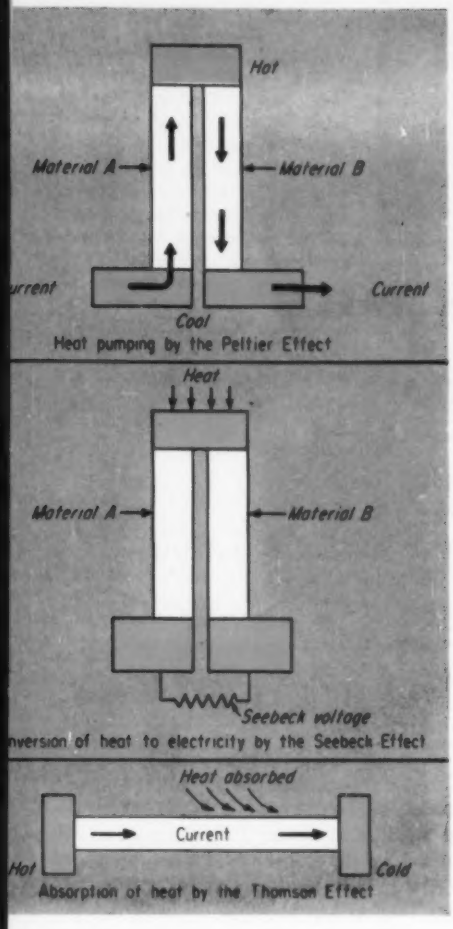
Photon propulsion offers so little thrust that it could only be used for outer space. It is based on the force of light—the "push" in a quantum of light energy—used to propel space craft. It's not much of a push (something on the order of 10^{-7} lb/sq. ft.), but only very small amounts of power should be required to move a vehicle through airless space; and, in the wide, blue yonder, there is almost no limit to the size of the "sail" that might be erected to catch the sun's light and put it to work. Speeds achieved may not be very high, but cargo shipments between planets might someday be made this way.

gravity control

There is one way, though, to permit ground-level use of low-power ion and photon systems: Find a way to cancel the force of gravity. Impossible? Scientists are no longer willing to take "No" for an answer. At long last, serious research is under way. It is not impossible now that a system will be found to control gravity or shield against it. When such a system comes, we can solve many of the problems of space flight and perhaps virtually eliminate need for portable power in operations that now require a tremendous effort.

energy conversion

In the conventional power plant, and in the nuclear plants now being built, production of electricity is a complex business. A furnace—coal-fired or nuclear-fueled



—heats water or some other heat-transfer medium. This generates steam which is conveyed to a turbine and allowed to expand, giving up its heat and spinning the turbine which, in turn, drives an electric generator. Isn't there some way to shorten the cycle—to produce electricity directly from heat? The answer is "yes." The ground work for such systems was laid many years ago (see above).

Solar and nuclear energy can be converted directly into electricity by a variety of methods, some using the heat of the sun, or the heat generated by radio-active decay; others using the radiation.

For instance, the sun's rays, or nuclear radiation, can be used to activate a semiconductor which, in turn, will become an electron source. They can be put to work in "batteries," to build the potential of a storage cell system. Or, they can be used to charge a capacitor directly.

The heat of the sun, or of a radioisotope, can be converted into electricity with the aid of thermocouple or semiconductor devices; or the heat can be used in a thermionic converter to "boil off" electrons and create a flow of current between two electrodes.

The "nuclear batteries" being developed as auxiliary power sources for space satellites, for instance, create a flow of current through semiconductor strips by heating one end with a radioactive isotope, while keeping the other end cool. Devices of this type are simple, compact, and have extremely long life. They will produce energy as long as the isotope itself lasts—for 5, 10 or 20 years without refilling or refueling.

The disadvantage of isotopes as heat sources, aside from any potential cost or safety problems, is that, while they supply tremendous amounts of energy per unit of weight or volume, they do it at their own rate of speed—a rate which cannot be changed by any chemical or mechanical means. Thus, while a pound of radioactive material may contain about 50,000 times as much usable energy as a pound of coal, availability of that energy must be spread over the full life of the isotope—and that may be 20, 50 or 100 years. The only way to increase the immediately available energy is to use more radioactive material—and that can be both costly and dangerous.

chemical conversions

Chemical methods of energy conversion are also receiving intensive study, with fuel cells (*PE—Feb 7 '58, p 18*) among the most promising. The fuel cell is a chemical-to-electricity conversion system, which, in effect, uses a "cold" combustion system—so termed because the energy of the reaction between oxygen and a fuel is converted into electricity with a minimum of heat.

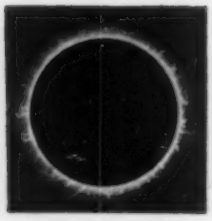
As its name implies, the fuel cell resembles a standard wet cell in outward appearance. It has two hollow, porous electrodes immersed in an electrolyte. The "fuel" is fed down the positive electrode; the oxidizer down the negative. Oxidation of the fuel takes place within the electrolyte by an indirect chemical reaction which is, in effect, electrolysis in reverse. The resulting potential set up between the electrodes causes a current to flow in a circuit external to the cell.

The advantages of the fuel cell are: extremely high fuel utilization (70 to 90%), and high output (perhaps as much as 300 watt-hr/lb). Right now, use is limited by the fact that the most successful cells use pure hydrogen as the fuel and pure oxygen as the oxidizer. Research is now underway on cells that can take coal or petroleum gases as fuel and air as the oxidizer. If it succeeds, it may not be too long before low-cost fuel-cell power is available for vehicles of all kinds at a cost competitive with that of standard wet cells.

Fuel cells may also help to solve the toughest problem in solar-energy utilization—storage of the energy for use during periods of darkness. It might some day be possible to set up solar cells to produce electricity for electrolysis of water to produce hydrogen and oxygen that could then be stored and fed to a fuel cell as needed.

what next?

This by no means exhausts the list of possibilities in energy conversion. There are all sorts of mechanical transducers that might be developed. There might be a non-nuclear low-temperature route to heat-to-energy conversion. An electrical potential has been observed during the freezing of water which might well be put to work. New scientific discoveries can be expected to add to this list. But what is most needed is a willingness to spend the time and effort to make full use of the technology we now have.■



at the edge of the unknown . . .

THINKING MACHINES NEED THOUGHTFUL MEN

"Know thyself" is the biblical injunction,
yet only in this century has man taken a few halting steps
in the practical study of human thought,
understanding and communication

RICHARD M KOFF
senior associate editor

In less than a decade, digital and analog computers have become an indispensable part of our daily lives. We're paid by punched-card check, billed by machine-printed invoice, birth-certified, taxed and probably will be stricken from the rolls by impersonal computer. Our airplanes and missiles are steered by computer, our chemical process plants are supervised and our machine tools directed by electronic controls based on computer principles.

It won't be long before a design engineer will be able to make 3-dimensional drawings on a 'scope screen by controlling a bank of knobs. A man-computer setup like that of the APT system, developed at MIT (*PE*—Mar 9, p 28), will then take over. The computer spews out a strip of punched-paper or magnetic tape ready to go into a numerically controlled machine tool for immediate production "in steel."

Business decisions will be guided more and more by machine rather than man. Sales forecasts, inventory control, production schedules and warehouses will have completely automatic order, reception, storage, packaging, addressing and delivery.

Weather forecasting will be more accurate, literature searches and abstracting will be done by machine. A steam-electric power plant is even now under construction which will be computer-run from startup to shutdown.

These applications (and there are thousands more) are certain. Computers have already done these jobs or are so close that it's only a question of economics, not science.

Improvements in the machines themselves can also be predicted with certainty. Bigger memory storage banks with faster access and less volume and power requirements are coming. Magnetically controllable superconductivity at cryogenic temperatures (near absolute zero) is offering some usable hardware. But, more important, cryogenics is teaching us about the behavior of materials when molecular motion is nearly stopped—and this knowledge will find application in solid-state devices. Faster input and output devices are under development as well. You now can buy a gadget that will print 100,000 characters per minute—it would print out the Bible in about 45 minutes.

Today the real bottleneck in computer application to straight problem solving is in programming—the step-by-step translation of a problem into computer terminology. New theories abound, and self-programming programs (in essence the computer does its own programming on the first run and solves the problem on the second) have been developed. They have a long way to go.

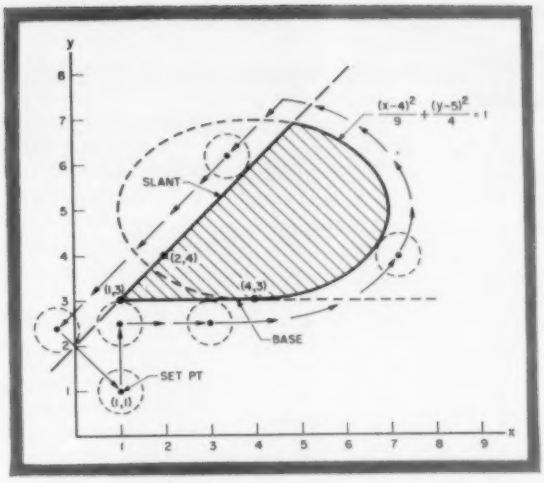
Despite the bottlenecks, computers have opened up a whole new world to engineers and scientists. Problems they didn't dare tackle before—ones that would have taken a man's lifetime to solve—have been answered in a few hours or minutes. All sciences have benefitted—from astronomy to nucleonics, from biology to archeology—and some new sciences have been fathered.

For example, mathematicians have invented or resurrected different kinds of logic and they have applied probability theory, statistical and system analysis to produce Operations Research, a powerful tool for businessmen as well as engineers—and made practical by computers.

But exciting as these developments are they represent improvements in, and applications of, familiar equipment. The breakthrough to a true thinking machine is still a long way from this hardware stage. But recently psychologists have teamed up with computer men and the combination has produced concepts strange to both disciplines.

A first hint has come from Dr. Frank Rosenblatt at

Numerical control of machine tools . . .
has taken a long step toward practicality with the Automatically Programmed Tool (APT) system. Here a computer receives simplified instructions in APT language easily learned by the engineer. The computer then writes the detailed step by step program needed by the machine tool to actually cut the part. The system, developed by MIT scientists working for the Air Force with the cooperation of Aircraft Industries Assn companies, promises to bypass the worst bottleneck in numerical control—detailed programming by hand.

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TL DIA/+1.0
TOLER/+.005
FED RAT/80
HEAD 1, MODE 2, ON SPIN, ON KUL
SET PT = FROM, POINT/1,1,3
IN DIR, VECTOR/0,1,0
BASE = GO TO, LINE/1,3,3,4,3,3
WITH, TL RGT, GO RGT, ALONG/BASE
GO FWD, ALONG, ELLIPS/4,5,3, $$
+.33333,0,0,0,5,0
SLANT = LINE/1,3,3,2,4,3
GO LEFT, ALONG/SLANT, PAST, BASE
GO TO/SET PT
OF KUL, OF SPIN, END, FIN1
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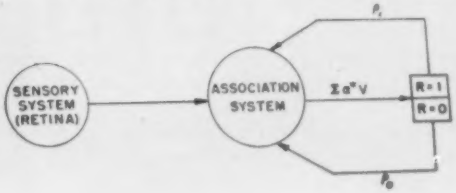
A simple perceptron . . .
has hundreds or thousands of receptor units in the sensory system randomly connected to cells in an association group. When activated, the association cells transmit signals to the response unit (R) which delivers a signal output and feeds back a reinforcing signal to the activated association cells. The reinforcement is a means of learning and memory because the value (V) of each association cell depends on its complete sensing history.

ORGANIZATION OF A SIMPLE PERCEPTRON



Cornell Aeronautical Lab. Dr. Rosenblatt is a graduate research psychologist who later studied electronics and computer design. Starting with a fundamental concept of how brain cell is connected to brain cell, Dr. Rosenblatt reasoned that similar connections could be made with artificial "cells" of comparable function though, of necessity, larger in size and fewer in number.

The theory checked out after some involved statistical analysis. A mathematical model was tested on a computer which verified the original thinking, and a prototype is now in the building stages.

The perceptron, as it is called, has several unique characteristics. It can learn to discriminate between classes of things (squares of all sizes are different from circles, for example). It remembers what it learns, and it does not have to be "programmed" or "patchpaneled" to do so. Once made, it is a self-contained unit that might receive information in the form of sound, electric impulse, photoelectric cell or just about any physical quantity that can be transformed into electric voltage.

This, then, is the first indication of how a thinking machine might be made. In principle the perceptron could read print or script, respond to verbal commands, do translations, digest or prepare abstracts of papers.

In the more distant future, automatic navigation and landing systems, automatic pilots and recognition systems of every variety are possible. Ultimately, perfected models might do our space exploration for us. Robots could be made indifferent to deadly environments and untroubled by century-long journeys to our stellar neighbors.

Fanciful? Perhaps, but it is difficult to picture any future without intelligent robots and it is exceedingly unlikely that a robot brain, built on current computer principles could be packed into a space smaller than Penn Station. By taking nature as his model, Dr. Rosenblatt has cashed in on 2 billion years of natural selection.

the power of thought

Simultaneous with developments in true artificial brains there has had to come a better understanding of how the human brain works. Few theories hold up for very long, but some fascinating experiments have produced results that promise (and threaten) major changes in our life-of-the-future.

Recently Russian scientists announced a "thought-controlled" prosthetic hand (*PE—Nov 10 '58, p 39*). They claim that the "mere thought of bunching a fist is fully sufficient . . ." A pickup senses the electric impulses running down the operator's arm and signals a mechanical hand to tighten. US Air Force and Veteran's Administration are reported working on similar projects.

How can this be? Is telepathy and thought control really possible? A definite relationship has been established between electricity and thought. Lie detectors are based on these principles and have been in use for years. Direct electrical stimulation of the brain cells of mice and cats has produced pleasure and pain and even induced a rat to ignore a plentiful supply of food until he starved. If electricity and thought are associated, the control of mechanical equipment (just think "open sesame"—and the cave door opens) by thought is just a step away.

More frightening is the reverse process. Thought control—while a bit strong even for George Orwell (1984) or Aldous Huxley (*Brave New World*)—could easily be

used to make a world of slaves. A small receiver imbedded in the skull at birth would take care of any shielding possibilities.

Absurd? Not completely. The violent public reaction to "captive audience" commericals, motivation research, and subliminal advertising indicates how serious people regard this invasion of their privacy. It also underlines our unwillingness to take a chance on letting even the unlikeliest thought controller get by. After all, thought control is practically unstoppable once started—you probably wouldn't even know it has been applied. For all we know it may have already begun . . .

one, if by land

The so-called commercial industries—publishing, radio, TV, advertising—dominate the transmission of ideas. But a new branch of mathematics promises to make them sound like baby talk.

Information theory was suggested during World War II by Norbert Wiener of MIT in a study of antiaircraft fire-control patterns. The theory was later applied by Claude Shannon of Bell Labs in a search for ways to transmit more messages in less time and through fewer wires.

Shannon reduced all information to its simplest form (yes-no, on-off units) and then rebuilt more complex messages with combinations of such "bits." With this standard of measurement of information content, a specialist can assign an efficiency rating to any message channel, whether it is between two people, man and machine, or two machines.

It is known, for example, that the English language is over 80% redundant. Therefore, a new language or symbology could be devised which would permit any book to be printed on ½ the number of pages. And there would be less ambiguity and fewer typographical errors to contend with since the system would be self-checking.

People won't take up a new language very quickly—the attempts to promote Interlingua and Esperanto have proven that, but information theory has already changed our world in less-obvious ways.

For the first time we can study the structure of language. Information theory will be instrumental in the design of a translation machine *(PE—Mar 25 '58, p 30)*. Voice-actuated equipment (even voice-operated typewriters) are in the works.

By extension, a better understanding of language must improve our modes of thinking—and ultimately the ideas themselves. It has been shown that children, untrained in the conventional rules of thought, are far more able to assimilate radical ideas than can their parents. They may like modern, atonal music for example, be at ease with free verse, study and apparently understand the concepts if not the mechanics of multidimensional space and non-Aristotelean logic.

It is now believed that this freedom comes from inexperience with language. Children do not think in words, therefore they are not limited to the meanings and inherent relationships of dictionaries and grammar.

Information theory therefore offers us the key that may ultimately free us from the imperfections of language. So psychologists and sociologists are using the terminology and equations in an attempt to understand how a human senses and interprets the outside world,—even how the human mind handles its own internal information.

Of greatest interest to scientists is the theoretically proven possibility of the control of "noise." This essentially random disturbance, necessarily included in every message channel, can be made all but negligible in its effect on a transmitted message. This means that perfect transmission is possible through an imperfect channel.

teaching machines

Something should be said here about the revolution in teaching methods now being prepared in the laboratories. By teaching machines we don't mean animated demonstration equipment or more widespread use of closed-circuit television. What we have in mind is the work being done by Prof. B. F. Skinner at Harvard.

A true teaching machine would actually replace a human teacher and yet still be able to respond to the thousands of different kinds of students it will teach. There must be constant interchange between student and machine—each reacting to the other. New material would not be offered until earlier ideas were understood.

Skinner's group has already tried devices to teach psychology, language and mathematics at college, highschool and elementary school levels. It will be a while before these machines are perfected, but they are our only answer to the anticipated teacher shortage, and may very well be the first application of known principles of learning.

whither science?

At the end of the last century we knew our world very well. After the solution of a few minor puzzles the final edition of the *Encyclopedia Britannica* could be printed.

Today the courageous explorer can start off in a thousand directions, and as long as he keeps up with advances in adjacent fields he is bound to turn up new ideas.

Discovery now comes from the mixture of sciences. Specialists only talk to their brothers. Who else can understand them? Their accomplishments are usually minor improvements in well-known areas. This is consolidation, not discovery.

But take a quick and intuitive mind, pour in the techniques and viewpoints of two or more specialties, and you're sure to have an explosion. Fifteen years ago the explosion was atomic. Physics and chemistry united to tear loose the very fabric of matter. Ten years ago physicists and metallurgists teamed up to produce the transistor—and electronics took its biggest step forward since the invention of the vacuum tube.

In a similar way the electronicist has moved into optics. (As his electromagnetic frequencies get higher and wavelengths shorter, he approaches visible light. Microwave guides, radio astronomy, radar antennae, even TV picture tubes show the influence of optical principles.)

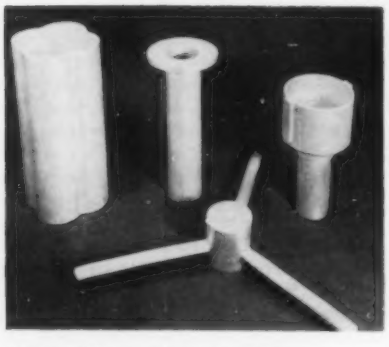
The walls between all physical sciences are crumbling and this can't help being a good thing. It won't be too long before our descendants study . . . well, what would you call it . . . life? Not physics, not mathematics, not biology or philosophy, but history perhaps (including the history of everything—not just the rise and fall of nations) and communication (the first and most-important tool). ■

SIGNIFICANT COMPONENTS MATERIALS PROCESSES

Adhesive bonds dissimilar unvulcanized elastomers . . .

and, in many cases, joins uncured stock to cured (*PE—Apr 27 '59, p 20*). Bonds are said to be flexible and to resist aging. Adhesive dries at room temperature or higher, forming its bond during curing, preferably at 250 F or higher. Typical bond strengths at room temperature between such combinations as butyl, neoprene, natural, SBR or nitrile rubber range from 20 to 50 lb per in. of width. When used with a primer, bonds are possible between rubbers and such materials as plastics or metals. An additive is necessary for use in direct contact with fabric. Particularly applicable where properties of two elastomers are combined into a finished product. Suitable for bonding conveyor-belt covers to bodies, wire and cable jackets to insulation, composite rolls and hose covers. Evaluation samples available on letterhead request. **Lord Mfg Co, Dept 88, Special Products Div, Erie, Penna.**

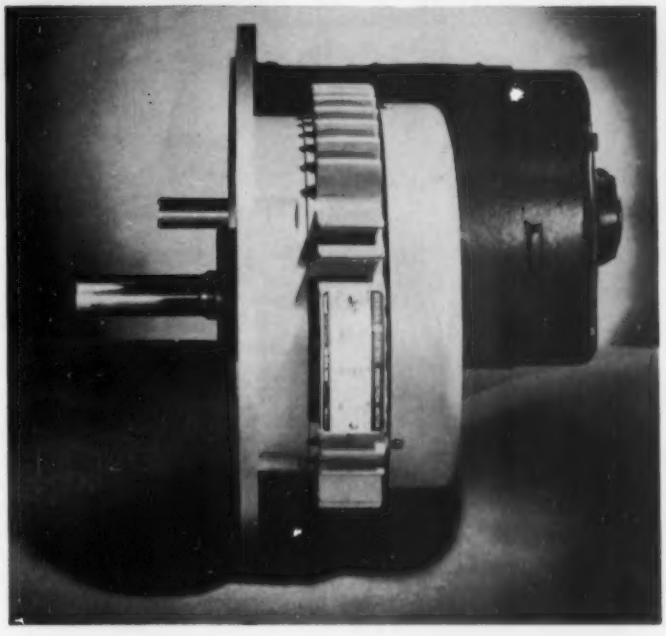
Circle 11, Reader Service Card



Lateral-impact extrusion . . .

technique is said to be capable of fabricating, in one stroke, complex aluminum shapes to close tolerances. A modification of the impact process, it makes possible metal flow outward at any angle from the direction of the impact stroke. (Pictured in foreground, surrounded by typical conventional impacts.) Said to permit economical production of parts that combine an intricate hub, or core, with such lateral extensions as spokes or vanes. Metal-working technique is now offered for commercial production. **Aluminum Co of America, 1501 Alcoa Bldg, Pittsburgh 19.**

Circle 12, Reader Service Card



Radial-airgap motor . . .

compared with standard NEMA Type D flange motors, is up to 55% shorter and 26 lb lighter. Design meets NEMA design B specifications for torques and starting current, and standard NEMA frame diameters are maintained. Available in polyphase dripproof and enclosed construction in ratings from 1 to 5 hp at 1800 rpm, and choice of three flanges. Motors mount in vertical or horizontal position. Insulation systems are said to resist water, heat and stress; varnish coating applied to stator assembly protects against failure due to moisture. Thus, heat-aging and dielectric characteristics are said to be improved. Size and weight reductions are achieved by use of formed end-turns on windings, separated from the stator core by an insulating end punching. Radial-airgap design decreases rotor inertia, allowing faster acceleration and braking and increasing reversing ability of the motor. Motor reduces overhang, takes up less aisle space than standard flange-mounted motors, and allows compact design of such equipment as machine tools, fans and blowers. Prices are comparable to GE standard flange-mounted motors. Now available on limited-production basis. **General Electric Co, Small Integral Motor Dept, Schenectady 5.**

Circle 13, Reader Service Card

Sintered-metal parts are sealed by process . . .

that impregnates a thermosetting plastic resin into the pores. Process does not alter appearance or dimensions in any way. Treated parts are cured under controlled temperatures until plastic is inert and permanently hard, rendering them pressuretight and nonabsorbent. Process is said to be unaffected by intermittent temperatures to about 400 F and to resist penetration of plating solutions, moisture, oil and most solvents. Prevents internal electrolytic and chemical corrosion and bacterial contamination. Generally, design, size or type of metal is said not to decrease effectiveness of process. Samples for test purposes will be processed without charge. **National Sinter-Seal Co, 608 Seneca Industrial Center, Buffalo 10.**

Circle 14, Reader Service Card

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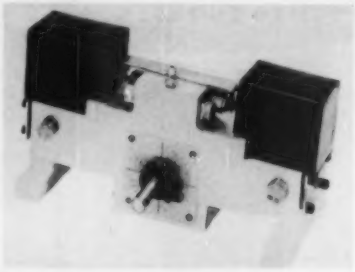


Rotary torque power unit . . .

operating at power input of 50 to 1000 psi converts hydraulic pressure into reciprocating rotary motion that can be controlled to suit various requirements. Power output at 1000-psi hydraulic pressure will provide 500 in.-lb working torque over a 5 to 360° range of shaft rotation. Unit will self-reciprocate within adjusted range of motion, as well as in semimanual or manual operation. Built-in speed adjustments control rotary shaft speed in either or both directions, eliminating need for separate flow controls. Incorporates wide variety of built-in controls. Electric solenoid actuation is also available for either or both directions of rotation. Since all valving and speed controls are built into the unit, installation requires only a hydraulic input pressure line and a sump line. Measures 13 x 6 x 5 in. deep. With electric solenoids, as illustrated, unit is 7 in. high. Actuating shaft has $\frac{3}{8}$ in. dia. **Industrial Sales Div, Cleveland Pneumatic Industries Inc, 64 Old Orchard, Skokie, Ill.**

Circle 15, Reader Service Card

Cure time of butyl rubber . . .

can be reduced to 10 to 60-min cycles at temperatures of 300 to 350 F by the addition of a bromo-methyl alkylated phenol-formaldehyde resin, which is also said to improve heat resistance and compression-set properties. No catalyst is required to effect cure. Uniform cures are achieved and rate of cure can be controlled by choosing proper grade of butyl rubber. Parts fabricated from the resin-cured butyl rubber are said to be capable of withstanding exposure to temperatures up to 500 F for long periods without losing resiliency. Resin may be added to a compound on the mill or in the Banbury. Properly compounded, it provides tack to butyl rubber. As a result of improvement in properties and handling characteristics, combined with butyl's characteristics, resin-cured butyl rubber is applicable to such products as diaphragms, gaskets and other molded parts, chemical hosing, and various uses in the transportation field. Resin is currently in commercial production. **Schenectady Varnish Co Inc, Schenectady 1.**

Circle 16, Reader Service Card

Variable capacitor . . .

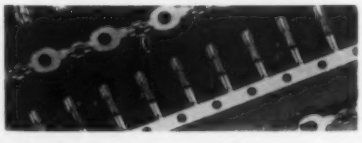
offers max capacitance of 4.4 mfd, as well as close tolerance adjustment over the whole capacitance range, continuous adjustability and accurate repeat operation. Operates in temperature of —4 to 212 F and within a voltage range to 200 v ac or 400 v dc. Offered in a wide range of standard types to meet requirements. **Plastic Capacitors Inc, 2620 N Clybourn Ave, Chicago 14.**

Circle 17, Reader Service Card

Twice the strength at 500 F . . .

of any known alloy is claimed for castings in an alloy consisting of magnesium, didymium and zirconium. Castings are said to achieve ultimate tensile strength up to 26,000 psi and yield strength of 16,000 to 19,000 psi at 500 F. The first castings produced in quantity from the magnisium alloy are missile components, which previously presented a heat-strength ratio problem when made of magnesium. Potential applications are also in airframe and electronic components. **Castalloy Co Inc, West Central St, Natick, Mass.**

Circle 18, Reader Service Card



Chain-form terminals . . .

connectors and receptacles are now available for use with automatic insertion machines for volume production lines. Line covers most requirements for printed circuits and other electrical and electronic applications. **Malco Mfg Co, Dept PE-1, 4025 W Lake St, Chicago 24.**

Circle 19, Reader Service Card

Heavy-duty limit switch . . .
with all major friction points of either nylon or oil-impregnated bearings is reported to have operated continuously beyond 45 million cycles, in inductive load tests, without any indication of failure. Switch, which measures $1\frac{7}{16}$ x $3\frac{7}{8}$ in. long, has full 600-v industrial rating. Extra-wide contact gaps, $\frac{1}{4}$ in., eliminate contact welding. Actuating force of 45 in.-oz will trip switch. Trip differential is 6°, while safety overtravel of 50° is provided in both directions. Limit switch is water-, oil- and dust-tight to NEMA 12 specifications. Available with three different bases and five lever styles. **R B Denison Mfg Co, 102 St Clair Ave NW, Cleveland 13.**

Circle 20, Reader Service Card

Eddy-current damper . . .
incorporates an overload protective clutch with 80 in.-lb capacity. Clutch may be externally adjusted to plus 10% or minus 30%. Damper controls undesirable forces, such as overtravel motions, oscillation, force surges and unstable speeds, by generating an opposing force in direct linear proportion to the input speed. Damping torque is 80 in.-lb/rad/sec. Operating temperature range is from —65 through 165 F. Damper weighs 3.2 lb. **Lyndon Aircraft Inc, 140-71 Clifford St, Newark 5, NJ.**

Circle 21, Reader Service Card

Swivel with metal seal . . .
is said to withstand high-pressure, corrosive hydraulic fluids. Metal seals achieve balanced hydraulic loading on metal seats. Stainless steel swivel is said to perform effectively while handling corrosive hydraulic fluids under pressures up to 4000 psi. Functional temperatures range from a liquid nitrogen low to 450 F max. Supplied to meet specifications and required sizes. Right-angle and straight-through configurations are available. **Propulsion Development Laboratories Inc, 1120 El Segundo Blvd, El Segundo, Calif.**

Circle 22, Reader Service Card

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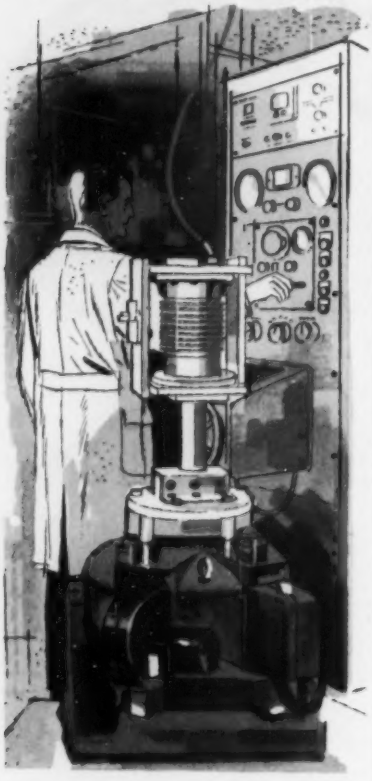

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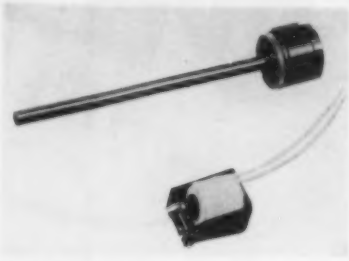

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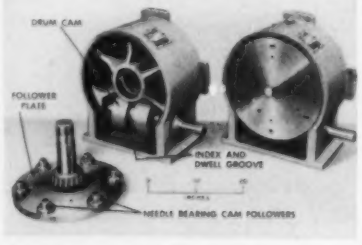

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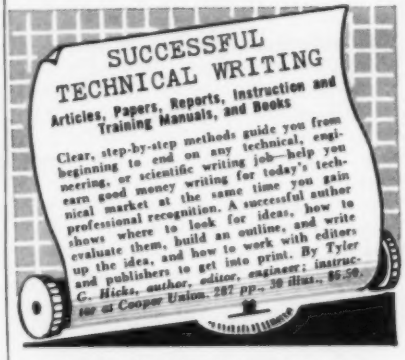
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Circle 25, Reader Service Card

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built for continuous duty is available at any single speed from ½ to 1000 rpm with torques up to 1/20 hp and 175 in.-lb at 10 rpm. Ballbearing motor, generated gears and pinions of hardened steel, and large felt oil reservoir touching every journal permit hard usage. All gear assemblies are copper brazed. Can be base- or panel-mounted. Totally enclosed with continual airflow over motor. 2-pole, shaded-pole motor is free from radio and TV interference. 115 v, 60 cps ac is standard. **New England Gear Works, 557 S End Rd, Southington, Conn.**

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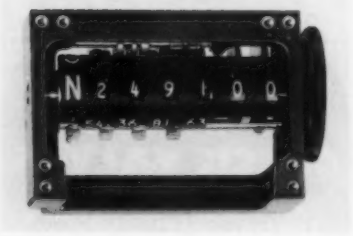

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has operating speeds up to 1350 rpm, built-in stopping points, thumb wheel for manual setting and can be supplied for use with servo-operated read-in and read-out. Operates in —65 to 160 F and withstands vibration along each principal axis through total excursion of 0.006 in. for 1 hr at 10 to 55 cps. Starting torque is from 0.5 in.-oz over full operation range. Corrosion-resistant construction includes machined aluminum housing. Counters have 2 to 10 wheels with white on black or black on white engraved figures. Digits are from 0 to 9 with vernier gradations. Counters operate in both directions from zero, with directional indicator. Unit is 3⅜ x 1⅞ x 2 in. and weighs 6 oz. Indicates temperatures, pressures, positions, distances or time for computers. Suitable for military, airborne navigational, automation and commercial applications. **Chicago Dynamic Industries Inc, Precision Products Div, 1725 Diversey Pkwy, Chicago 4.**

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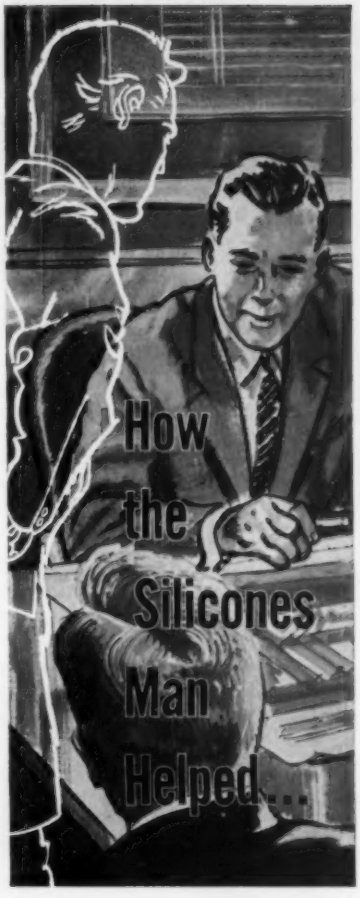

RUBBER THAT TAKES A 350 F PINCH

The rubber-covered pinch rolls used in a vinyl sheet laminating machine had to be changed every two weeks. The 350° F. operating temperature and high pressure caused the rubber to crack, become hard and glazed, making frequent regrindings necessary. After a few regrindings the rolls had to be completely resurfaced. Since the press was in operation around the clock, these delays were costly.

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To help resolve this situation, UNION CARBIDE developed a silicone emulsion softener that works well with stiffeners, giving fabrics a better hand and eliminating the tendency of wet cloth to pick up or retain soil. The silicone emulsion is not harmed by chlorine, doesn't yellow with age, and won't water spot.

Other advantages of the new silicone emulsion lie in its ability to provide fabrics with greater durability and tear strength, better abrasion resistance, and non-scorching properties.

FAST, ACCURATE CONTROL OF FOAMING SYSTEMS

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Its chemical inertness and oxidation resistance extend the effectiveness of silicone antifoam over long periods. Since it is low in volatility, the antifoam works well at elevated temperatures. It is not irritating to the skin of those who work with it.

The Silicones Man is accustomed to helping solve problems like these . . . and he may be able to help you, too. For background information on these and other applications, write Dept. EP-0902, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

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Operations Research in Industrial Management

D M CHORAFAS, PE. Reinhold Publishing Corp, 430 Park Ave, New York 22. 303 pp, 6⅜ x 9¼. $8.75.

As the title indicates, this book is intended primarily as a guide in applying games theory, simulation and mathematical programming to executive decision making. But it can also be understood and perhaps applied by engineers–and even many with less mathematical background–to everyday work in a wider variety of fields than the author indicates.

For as Chorafas points out in his acknowledgements, he has attempted an integrated approach to what he terms systems engineering. The book's wealth of examples, applications and case studies should provide a relatively easy way of helping many readers explore the possibility of applying this new mathematical tool to his own work. –JK

Finding and Developing Engineering Personnel

Two companies discuss how they find, evaluate and develop engineering personnel. Interviewing techniques, recruiting standards, how salaries are set, job analysis, performance reviews and rating methods, and an organizational chart based on specific potentials of individual personnel are all discussed.

"Finding and Developing Technical Personnel," R G Alleman, E I DuPont DeNemours & Co, and W E Alexander, Monsanto Chemical Co, Mechanical Engineering, Apr '59, 29 W 39th St, New York 18.

Bearings and Seals

Operation of bearings at speeds to 140,000 rpm is reported, with reference to lubricants for up to 625 F. 1000-F bearings of several different materials are also described, and information on powdered lubricants, capacity, wear, friction. Also included is some data on dry operation of high-speed, high-temperature shaft seals; oil-throwaway lubrication of bearings at 800 F using conventional lubricants; use of Freon 12 as bearing lubricant in liquid and vapor phases at −18 F to 100 F; development of a Freon 12 shaft seal.

"Bearing and Seal Development," Stanley Gray, Stratos Div, Fairchild Engine & Airplane Corp, Mechanical Engineering, Apr '59, 29 W 39th St, New York 18.

FILM DOCUMENTATION–Booklet, 16 pp. Tells story of division formed to provide film documentation and technical film services for military and industrial clients. Presents staff, facilities, and services available; discusses costs; gives typical film examples. Cinefonics Inc, Div Cook Electric Co, 2700 Southport Ave, Chicago 14.

Circle 1, Reader Service Card

ELECTRONIC SYSTEMS PROGRAM–Brochure, 12 pp. Discusses history, personnel, services and facilities for design and manufacturing special electronic equipment and complete systems. Includes listings of some specialized equipment completed or near completion. Instruments for Industry Inc, 101 New South Rd, Hicksville, NY.

Circle 2, Reader Service Card

IN-PLANT TRAINING–Brochure, 3 pp; catalog, 32 pp. Offers details on procedures for setting up and servicing in-plant study groups using MEI courses. Catalog also discusses home-study instruction in technical metal subjects and gives course information. Dept RV-1, Metals Engineering Institute, 7301 Euclid Ave, Cleveland 3.

Circle 3, Reader Service Card

HOW TO PACK IT–Brochure, 32 pp. Covers proper selection of corrugated packaging for a new or existing product. One section is devoted to basic box designs; other to special designs. Hinde & Dauch, Sandusky, Ohio.

Circle 4, Reader Service Card

NEWSLETTER–Vol. 1, No. 1, 4 pp. New quarterly, "The Interpreter," is edited by Frank Tatnall, vice-president. Devoted to news about strain-gage developments, testing equipment, strain-gage application and performance. Tatnall Measuring Systems Co, sub Budd Co, Box 245, Phoenixville, Penna.

Circle 5, Reader Service Card

CONTRACT MANUFACTURING–Brochure, 6 pp. 18 photos of components and equipment produced to customer specifications are shown along with 21 plant photos of equipment and production facilities. Farwell Metal Fabricating, 81 W Fairfield Ave, St Paul 7.

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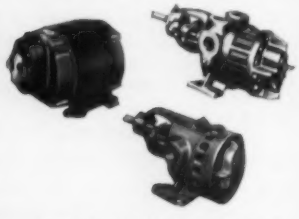

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Publisher's Postscript...

take the time to SEE *and* LISTEN

Never before in the history of the product design engineering profession have so many materials, parts, and components manufacturers put so much money on the line to exhibit and demonstrate their products. The Design Engineering Show in Philadelphia the last week of this month will be a highly specialized show—not for the public—but specifically organized and planned exclusively for the engineers engaged in the design and development of America's new and improved products.

I can't imagine any design engineer who will not want to spend at least a day or two looking over the millions of dollars worth of new ideas that he will be able to see, test, compare, and evaluate. Most exhibitors will have competent engineers on hand to talk your language, answer your specific technical questions.

In addition to the display of the elements with which you must work, there will be important engineering conferences dealing with the three major areas of product design—Mechanical, Electrical, and Materials. These meetings, conducted by outstanding experts in the field of product design and development, alone are worth your taking the time to come.

Do plan now to come to Philadelphia, May 25 to 28. Just three weeks ahead. If you want to save time, write today for your rapid registration cards. We'll help you. Just write SHOW on the reader service card on the facing page, in the placed marked SPECIAL DATA, and print your name and address below. After the word SHOW write the number of registration cards you'd like to receive. We have arranged with the show management for an adequate supply of these cards, and the day we receive your request the cards will be put in the mail to you. We don't get any "rake-off" from the show management—we're doing it only as a service to you, and because we sincerely believe every reader will definitely profit by being among those present.

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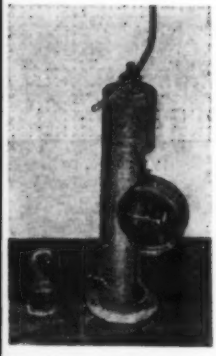

Build-your-own tensile tester

A portable bonding-strength tester that that can be made from standard components has been devised by engineers at W C Dillon & Co. One of its two units is a simple assembly—Dillon dynamometer and screw jack. The other is a plug-and-hook anchored in the test material. To test the adhesive or other bonding system used with the material, just place the jack assembly over the hook, with the latter engaging the dynamometer clevis. Then turn the jack until the bond gives way. Its breaking strength is read directly in pounds. Dillon says the technique can be applied to "almost any resinous or sheet material."

Carbide cut-ups

Carbide-surfaced stainless-steel kitchen knives, now being market-tested in the East by Robeson Cutlery Co, Perry, NY, are among the first products of their kind to take advantage of the Linde flame-plating technique. This high-temperature process can deposit a thin, wear-resistant coating of tungsten carbide on a metal base by literally shooting it out of a gun. The refractory particles are suspended in a mixture of oxygen and acetylene, and propelled by detonating the gas.

With the carbide coating on one side of the blade, the knives "sharpen themselves as they're used," and should last almost indefinitely. Prices will range from $2 for a 3-in. paring knife to $21 for a 6-pc steak set with wood chest.

Who needs a match?

Here's a butane torch cigarette lighter that's powerful, adjustable, trigger-operated, and packed with a 5-year fuel supply. The maker, Brown & Bigelow, St Paul, Minn, says proudly, "It's the only lighter designed to rest horizontally on desk or table, and . . . embodies the principles of 'ergonomics' or 'human engineering.' Its design fits the natural action of the body in reaching, grasping, bringing into position and lighting with the greatest ease."

It has a die-cast body that incorporates the gas chamber, and a plastic housing. Flame height and intensity can be regulated by a ball-orifice and wick arrangement. It's just under 6 in. long, 2½ in. wide at the top, weighs a little over half a pound. Price: $16.95.

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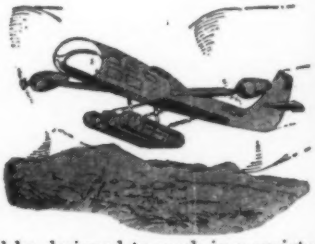
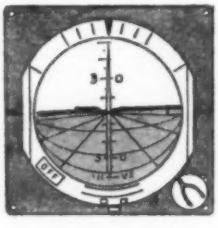


. . . aircraft landing gear for rough terrain. STOL aircraft can operate from very short fields, if the ground is relatively smooth. Equipped with special gear, they could land and take off from any field that was clear of major obstructions and reasonably level. Such gear should be designed to work in a variety of unprepared surfaces—marshes, plowed fields, rocky areas—and must be lightweight.

. . . a starting motor engagement drive for internal combustion engines that will operate from −65 to 125 F. Bendix drives and other inertia couplings occasionally jam if not specially lubricated for low temperatures. But the same lubricant is not suitable for high temperatures. Preferably, the drive should be of the flywheel-ring gear type.

. . . a method of avoiding radar jamming countermeasures. The strategic value of radar for target-spotting and detection is limited because of a number of successful jamming techniques—CW jamming, noise jamming, pulse jamming, chaff, spoofing and artificial glint. A method of countering these countermeasures is needed.



. . . an aircraft instrument that indicates true vertical and does not respond to accelerations in a horizontal plane. Must be simple, operating on a principle that does not involve a gyroscope.

. . . an argon scavenger for nuclear power plants. Air with argon becomes radioactive as it passes through the reactor and therefore cannot be exhausted back into the atmosphere. If supplied with argon-free air, a nuclear power plant could operate on an open air-cycle.

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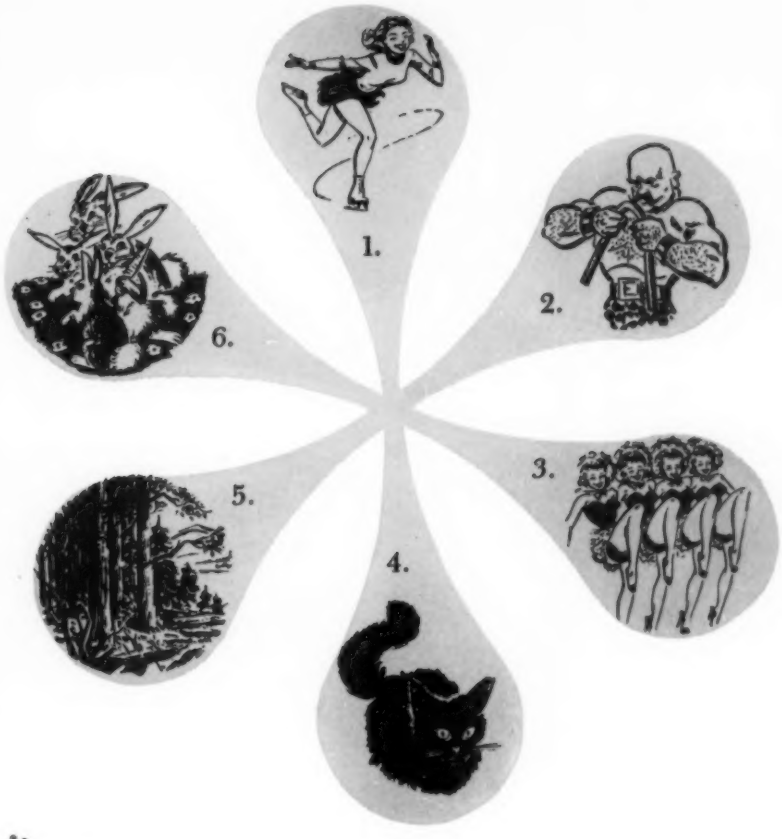

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1. **SMOOTHNESS**—The pencil lead must be absolutely free of grit and hard spots. It must glide across the paper like an Olympic skater on ice.

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